SCIENTIFIC AMERICAN SUPPLEMENT

VOLUME LXXXVI
NUMBER 2238

★ NEW YORK, NOVEMBER 23, 1918 ★

Published weekly. Entered as second class matter, December 15, 1887, at the Post Office at New York, N. Y., under Act of March 3, 1879.

10 CENTS A COPY
$5.00 A YEAR

Threshing the wheat crop in Nebraska

WHEAT FROM THE FIELD TO THE TABLE [See page 329]

The Bio-Chemical Characteristics of Species*

Efforts to Discover a Specific Differentiating Substance

By Dr. Louis Legrand, Laureate of the Academy of Medicine, Paris

Every living species whether plant or animal is distinguished primarily by the form of the individuals which compose it. The study of these forms of organisms and of their tissues is the subject of the morphological sciences: Zoology, botany, anatomy and histology. But while the knowledge of the phenomena of life is conditioned by the view, microscopic or macroscopic, of living bodies, it is rapidly limited by the difficulties involved in interpreting the details which are perceived as we approach the molecular structure of plasmas; and the study of the ultimate elements of living bodies is outside the scope of the morphologic sciences.

But another science, that of organic chemistry, which has undergone a prodigious development during the last half century, is engaged in the analytical and synthetic study of the products of life; however, these products are no longer living; they are the scattered fragments of a ruined structure which the more or less chimerical efforts and hopes of a few great minds have endeavored to reconstruct; during the last hundred years, in fact, the most eminent chemists have succeeded in rebuilding from such fragments, if not a compact and symmetrical structure, at least a solid foundation following the discoveries of Chevreul upon the constitution of organic substances, and those of various other scientists down to the quite recent syntheses of the sugars and of the polypeptids.

But as yet no one has solved the great problem: How are these little fragments of living substance associated in the natural state so as to form living plasmas? What are their qualitative and quantitative proportions in the plasmas of each species? It is true that this idea has already engaged many eminent chemists, physiologists, and biologists, including Spencer, E. B. Wilson, Charles Richet, Dastre, Hallion, Leduc, M. F. Guyer, LeDantec, J. Loeb, Huppert, Benedikt, Fick, etc.—this idea that the morphology of each species depends upon its chemical structure, just as each crystal of a salt, to use Spencer's comparison, owes its form to the molecular composition of the said salt.

It appeared as if the finding of the specific substance was only an affair of reagents and skill in analysis, and for more than a quarter of a century precision of analysis has seemed so perfect as to be able to detect not merely the species but even the varieties: thus, A. Gautier made the discovery of very definite chemical differences between various kinds of grape vines, and the hope was excited that the process might be extended among the various living types.

Numerous analyses have been attempted in fact, in various quarters, with this object of discrimination between species, and the present article is intended to demonstrate that this idea of distinct plasmas which has been in the air for some little time, is soundly based upon facts discovered by observation and experiment. It may even be possible later to deduce certain ideas regarding the probable constitution of living tissues with respect to the unit and the apparent immutability of the species. But no one has as yet been able to state the formula of the protoplasm of a single species. . . . And perhaps biological chemistry will never have other material than dead tissues as material for study. Hence the following lines must consist in the fragmentary enumeration of certain physico-chemical facts, which appear to be the ones most applicable among those capable of throwing light on the existences of zoological chemical specificity.

It is evident, for example, that we can readily make a complete or fractional analysis of every living species if we extract and weigh separately each substance or compound contained in the cadaver of the individual; thus Mayer and Schaeffer were able to calculate the percentage of water in the same organs of certain types of Vertebrates and found it to be remarkably constant for the same species—approximately 2%. Zaleski, and later Lapicque, made a study of a simple body which is rarer though universally found in this division, namely, iron; they discovered the following percentages of iron in the liver of animals systematically approximate: in the liver of a rabbit .40%, of the hedgehog 9.8%, of the squirrel 0.5%. In certain cephalopods the corresponding metal is copper, which in the form of the albuminate with 0.38% of the metal forms the hemocyanine. This metal was detected by Henze in the liver of the cephalopods with a content likewise specifically variable, but ten times as great as that or iron among Molluscs, the percentages being 5.00 to 0.76% for the octopus, 0.32% for the *Sepia officinalis*, and 0.19% for the Eledone. Furthermore the bloods or cavitary liquids containing hemocyanine furnish a scale of oxygen absorption which differs in each species (Cuénot). Thus one hundred cubic centimetres of liquids will absorb the following amounts of oxygen: *Helix pomatia* 1 to 2 cubic centimetres, *Limulus polyphemus* 2 7/10, *Astacus fluviatilis* 2 to 3, *Homarus vulgaris* 3 to 4 8/10, sea-urchin 0.5/10, Carcirus moenas 3, *Porpurus puber* 3 to 4, *Cancer Pagurus*, 2 4/10 to 4 4/10, Maia Squinado 4 to 4 6/10. Even the metal zinc has been found in the *Fulgur Carica* and in the hepato-pancreas of a large carnivorous Gastropod, the *Sycotypus canaliculatus*, in which it constitutes 11% of the ash.

In these cases we are concerned with metals which have a catalytic and respiratory function and with special forms of apparatus: these are analyses of so-called "functional" bodies. When simple bodies of this sort (iron, for example) having a catalytic function unite with living matter they enter into the constitution of those giant molecules whose molecular weight has been determined in figures which are themselves strictly specific: thus the oxyhemoglobin of the dog (molecular weight 16.077), differs from that of the horse (16.218), and both of these from that of the ox (16.321), (Hueffner & Ganser). In the same way each plant species manufactures not merely one but several chlorophyls peculiar to itself (Gautier and Etard).

All authorities are agreed that the eggs and the spermatozoids, either one or the other, or both, act as vehicles of specific substances; but the question has been raised whether this constitution, which is evident in their case, forms an exception among the cells of the organism, or whether these special cells are distinguished merely by a superabundance of these special products. However this may be, the isolation of these products has often attracted chemists, at least so far as concerns those species whose eggs are hatched externally, and there have been discovered various organic bases of a moderate degree of complexity, sometimes strictly specific as the name indicates, although chemically very similar.

From the ovary of the *Perch*, Moerner extracted a "percaglobuline," while Kossel obtained from the ovary of the *Cyclopterus lampus* a "cyclopterine" (a protamine of the aromatic group). The "ichtuline" from the eggs of the codfish differs from that of the eggs of the carp by the fact that it decomposes into a special paranucleic acid called ichtulic acid. Hugounenq extracted from the ovaries of the herring a "clupovine" which differs markedly from the "ichtuline" of the eggs of the cod. This clupovine, taken as a type of these organic bases, yields upon hydrolysis less than 5% of the hexonic bases, histidine, arginine, lysine, but 20% of leucine and 50% of other acid amides. From the eggs of the green frog, Galimard extracted a "ranovine" containing a larger proportion of histidine than does clupovine, which otherwise it closely resembles. Kuradjeff discovered the specific protamine, silurine, in the spermatozoids of the *Silurus Glanis*; and in the testicle of the *Acipenser Stellatus* he found an "acipenserine" which differs from the protamines of the salmon group and is similar to sturine. Kossel isolated the following bases: nucleinate of salmine from the milt of the salmon, nucleinate of sturine from that of the sturgeon, and nucleate of scombrine from that of the herring.

An observation made by Phisalix indicates a connection between the "soma" and the "germen," in other words between the organism as a whole and the ovary. I refer to the fact that the glands in the skin of the female toad empty themselves of the poison they contain in order to provide the ovary with materials for the elaboration of the eggs, and in the latter there are found the two poisons which are characteristic of the species, namely, bufotaline and bufotenine. The same author likewise pointed out other peculiar kinds of venom in the blood of serpents and of other batrachians whose utilization by the ovary is quite certain. We may recall here also the observation made long ago by Miescher regarding the production of eggs by the salmon, to the effect that these fish, which take no food at the time of spawning, draw upon the muscular masses in their sides to furnish material through histolysis for the growth of their genital glands.

A great many of the lower animals, and likewise many plants, are remarkable for their ability to manufacture definite chemical substances which are elsewhere in the world of living creatures either very rare or entirely unknown. Thus the *Alnus incana* often has upon its young branches a deposit of a waxy varnish produced by a cockroach, Psylla Alni, and this wax is the ether of a peculiar acid called psyllostearic acid. The juice of the fig tree contains a peculiar rennet known as sycomycase, but it also contains an antiferment like that found in cow's milk. From the variety of bean called the *phaslolus lunatus* there can be extracted a cyanogenetic glucoside called phaseolunatine. Mirande has discovered a special glucoside called rhinanthine in the ligneous conducting apparatus of the broom-rape. Again we may have a well known protein which is almost specific, such as zein from the endosperm of maize and the gliadine of wheat.

Moreover, it is very suggestive to observe the relative proportion of certain compounds in the living plasmas of closely related species: thus Schultze and Winterstein found a much higher proportion of arginine in the *Lupinus luteus* than in the *Lupinus angustifolius* or the *Lupinus albus*; hence the specificity is connected with the mode in which these diverse substances are associated. For example, we may cite the distribution of the "generic" glucosides in the closely related trees, the willows and the poplars: the *salix purpurea*, *salix helix* and *Populus alba* contain both salicine and populine; the *salix alba* contains only salicine; the *populus monilifera* only populine; and finally, the *salix babylonica* neither salicine nor populine (T. Weevers).

Another proof, somewhat indirect, of the reality of the specific chemical nature of organisms is provided by the different use which different creatures make of certain substances, for example, the human organism takes from the drug caffein one methyl group, while the dog abstracts two, and the rabbit three groups. Albanese, who observed this fact, has noted similar modifications in case of theobromine, the active principle in chocolate. Schittenhelm has pointed out that the extracts from the spleen of the ox and the horse transform adenine and guanine into uric acid, while those similarly derived from the pig and the dog are not fitted to accomplish this chemical degradation.

It may be noted here also that the vital excreta of the cultures of Protozoa, microbes, or yeasts in definite mediums are so individual as to furnish a valuable basis of specific determination; the two acetic ferments can be distinguished in this manner—the *Bacterium xylinum*, or another of vinegar, yielding dioxyacetone with glycerin while this substance is entirely absent from the cultures of the *Mycoderma aceti* of Pasteur.

We here pass from pure chemistry to biologic reactions, which in certain respects are more precise and which have attracted many investigators. Among the protozoa specificity can generally be readily shown by the appearance of one product or another; for example, Abderhalden and Pringsheim have isolated separate peptolytic ferments from the juices of the *Mucor*, *monilia*, *Rhizopus*, *Aspergillus*, and *Saccharomyces*. It is a well known fact that the soluble products resulting from the life of Infusoria in limited cultures cause the death of these creatures at the end of a certain time merely through the presence of an excess of these products. In other words, these organisms may be said to be poisoned by their own excretions. The necessity which farmers are under of having a rotation of crops on a given piece of land has been explained in the same manner, namely, that each species of plants produces a toxic substance peculiar to itself (not yet isolated) which emanates from the roots and remains in the soil where it exerts an inhibiting action only upon plants of the same species.

Among the higher animals the same thing is shown in the *humoral* reactions of the blood or serum, which of late years have played so large a part in the diagnosis and treatment of human maladies. For example, the coagulines extracted from the red brood corpuscles have a distinctly specific but quantitative action, for they will cause blood of the same species (the cat) to coagulate more quickly that that of another species not very different (dog, rabbit), as demonstrated by Loeb and Fleischner. In general it may be said the

*Translated for the Scientific American Supplement from *Revue Generale des Sciences*.

lipoids of the red corpuscles are poisonous for a different species but inoffensive for individuals of the same species.

The success of seric precipitation is an admirable means of verifying zoologic relationships. The serum of the rabbit treated with the blood of the anthropoid ape gives a precipitate with human serum (Wassermann and Schultze), and the serum of the rabbit prepared with the blood of the *Rana viridis* precipitates that of the *Rana Fusca* but not of the tree frog (*Hyla arborea*) or of the toad. The serums of different vertebrates have enabled Jacques Loeb to obtain a beginning of parthenogenetic development in the eggs of the sea-urchin, and since then Jacoby has been able to increase this unexpected aptitude of foreign serum (of the rabbit, for example) by previously injecting intraperitoneally the sperm or the eggs of the same species which it is desired to develop through parthenogenesis, and this is likewise an indirect but still specific sensitivization. Achard and Flandin established by experiment the fact that in active anaphylaxis the antigene is endowed with a definite zoologic specificity and it even seems very probable that the complex formed by the anaphylactizing poison with the lipoids of the nervous substance, differs according to the species.

Among the mammals made use of in the laboratory it is known that the cell toxins are composed of two separable portions, one of which, the fixator, is identical in all, while the other is peculiar to the zoologic type; but to each cellular group there corresponds in the organisms a single antibody or fixtor, whatever the animal which manufactures it, and this throws light upon the intimate structure of living plasmas in which *the zoologic chemical specificity is paralleled by and involved with a functional cellular chemical specificity.* Thus Bordet and Gengou demonstrated that by preparing an animal of the species A through injection of the plasma or serum of the species B there can be obtined from A serum which neutralizes the fibrin ferment of the blood or serum of the species B, and this anticoagulant action on the fibrin ferment always retains a strict specificity.

In general it seems to be a fundamental fact and one demanding explanation that proteins of the same kind coming from different species are very similar to each other as regards their quantitative constitution: thus, the musculosins and the hemoglobins from fishes, from Molluscs, and even from the ox and the goat, yield, upon hydrolysis, almost the same quantities of the same acid amines, but are always biologically distinct as shown by the reaction of the precipitines and of anaphylaxis. They are distinguished also by the fact that they are more readily assimilated as food by the same species. Thus Busquet showed that the frog could be supported by a smaller amount of albumin if fed with the flesh of the same batrachian than when given veal or mutton; and in the case of frogs suffering from starvation the weight could be increased by a smaller amount of this specific flesh than by foods of foreign character. This, however, is only a question of degree as is indicated by the effect upon foreign albumens which are taken into the system by some other method than through the alimentary canal; in such cases there is a nephro-toxic action that has been pointed out by many investigators, particularly by Linossier and Lemoine in 1910. It usually happens that these foreign albumens force themselves through the filter of the kidneys, which they injure, and are found in the urine, but in some cases a singular tolerance has been observed to exist: for example, the dog readily supports the serum of the sheep and of the horse, and the rabbit that of the calf. This seems to indicate that the organism into which the foreign albumen was injected has the power of "rectifying" assimilating or "homologating" more or less quickly the foreign circulating plasma. However, if the latter comes from too distant a type (the albumen of the egg) it usually retains its poisonous qualities.

We must not fail to mention at this point the singular adaptation in female mammals of certain sebaceous excretions into the lacteal secretion. While the nutrition and growth of the young animal are doubtless better promoted if it is fed upon the milk of its own species, yet, if need be, it can assimilate foreign milks so long as its digestive enzymes suffice to correct and compensate the differences between the proteins ingested and those of its mother's milk, since the fats and sugars in the various lacteal fluids are almost identical and differ only in their respective proportions.

* * * *

With respect to biologic reactions there are few experiments more suggestive than that of Jensen in 1892. Operating on certain Foraminifera (Orbitolites, Amphisteginae) he proved that young individuals of the same species could be united by their pseudopods, while in the adults pseudopods separated from the body could not be reincorporated except upon the same individual. This seems to prove that age causes certain acquired chemical differences to appear in each animacule.

When the tail of the tadpole of the *Rana sylvatica* is grafted on the body of the *Rana sylvestris* the tissues of the two species exert no reciprocal influence; each tissue regenerates a tissue similar to itself with its own specific characters, each cell preserving the type from which it came. The same specificity is exhibited in the tests made by Wetzel of the possibility of an "illegitimate" graft upon the Hydras. The union between individuals of different species (*Hydra grisea* and *Hydra fusca*) is never so successful as between individuals of the same species, and each regenerates only the portions removed from its own body, so that there is never a genuine union. The grafts between *Hydra viridis* and *Hydra fusca*, or between *Hydra viridis* and *Hydra grisea*, usually failed, and the fragments separated after a few days. L. Guignard observed in the course of his experiments with grafts between the *Rosaceae* containing hydrocyanic glucosides that the migration of these products from one individual to another did not take place unless they belonged to two species of the same genus and produced the same glucoside; otherwise there was no transfer from the graft to the host or vice versa.

Furthermore, the results of the heteroplastic graft are well known and always indicate the same thing, namely, the specificity of humors and tissues. This is shown, for example, by the transplantation of the ovaries, which degenerate after being grafted upon a foreign organism (cat, dog, guinea pig, upon rabbit) but which remain capable of living and even of maturing their follicles upon animals of another variety but of the same species (W. Schultz). This law seems to be much the same among the Invertebrates, and Meisenheimer succeeded in grafting the ovaries of the caterpillars of the *Lymantria japonica* (same genus), and the eggs of these ovaries reached maturity, though they disappeared when transplanted upon a remoter butterfly, such as the *Porthesia similis*.

Plasmatic specificity also involves indirectly the existence of parasitic specificity. Parasites sometimes become biologic re-agents of such delicate sensibility that they pass over the species and select one of its varieties: the typical example of this is the famous and so-called providential immunity of plants of the American grape to the *Phylloxtra vastatrix*. Highly specialized parasitic insects live upon certain closely related Conifers: the *Chermès Piceae* on the *Abies pectinate*, while the *Abies normannia* is attacked by the *Chermès nuslini;* the *Picea alba* supports the *Mindarus obliquus* and the common fir the *Mindarus albatinus;* in the same way the Rusts of Cereals limit their parasitism to a single species, or at most a small number of related species. But how many butterflies, how many Coleoptera live upon the juices of a single species of plant? The enumeration of these is indefinite, and it would almost seem as if each plant species has its own parasitic insects or special group of them. It may be observed, also, that one of the rare examples known of the sudden appearance of a new animal species coincides with the change in the tree from which it derived its food which was forced upon an insect by migration: we refer to the celebrated cochineal insect of Robinier, the *Lecanium robiniarum*, which according to the precise and prolonged observation of P. Marchal is merely a sudden mutation of another species, the *Lecanium corni*, a mutation dating from thirty years before.

The specialization of internal parasites is still more suggestive: among reptiles an endoglobular parasite corresponds to each species (P. L. Simon); there are distinct Sporozoa for each species of Myriapod; each Halcyon has a special Copepod (Lamippidae) (A. DeZulueta); each Lamellibranch supports the porospores of a Gregarine parasite. Among the various Entozoa, the Taenias or tape worm for example, there is a two-fold specificity, for the worm passes through a complex vital cycle which makes it a necessity for it to find two hosts which are very remote from each other in nature. In their turn these parasites react chemically upon the host on which they feed, giving rise to bio-chemical reactions of the greatest interest, which enabled Weinberg and Parvu to detect the corresponding antibodies in the infected organisms of the Echinococcus or intestinal worms.

* * * *

If we now pass from purely chemical reactions into the domain of physics this other method of attacking the problem furnishes another confirmation of the existence of a plasma forming a material basis of the species. Such, for example, is the point of congelation of the muscular plasmas, which, according to F. Kryz, have a correspondence in agreement with their zoologic relationship without reference to the temperature and their habitats. This point is the same for the land turtle and the mud turtle, and is nearly the same in the various Batrachians. Furthermore, Portier has observed that the congelation point of the serum of polar animals (Reindeer, Blue Fox) is very near that of the domestic animals of the same group; for the seal it is intermediate between that of the Dog and of the Cetacea; there is an exception to this, however, in the case of the marine Palmipeds, among whom this point differs markedly from that of the terrestrial birds of the same group.

Plant products, the oils for example, exhibit similar properties which are well known and made use of in the laboratory; there are optical differences also between grains of starch: these accompany physical differences such as the aptitude for swelling and forming a paste; thus, potato starch forms a paste at 65°C., that of wheat at 70°C., of maize at 75°C., of rice at 80°C.

Furthermore, the specificity of plasmas is revealed by the form of the crystals in vital excreta. Bartochevitch observed that the phosphate crystals which are formed in microbe cultures on gelatine after desiccation present a different crystallographic type for each species of *Bacillus prodigiosus, subtilis*, and *ramosus Sarcina lutea, Saccharomyces.* According to Ernst Siphonea Algae of the genus *Derbesia* are differentiated by their crystals, the species *D. tenuissima* forming in its protoplasm prismatic or pyramidal crystals of oxalate of lime, while two closely related species *D. Lamourouxi* and *D. neglecta* are lacking in this salt.

* * * *

Such are the experiments and observations which speak in favor of the existence, in the two vital kingdoms of substances or plasmas peculiar to a single species: in other words, among all the plasmas of which each individual of the species is composed there is one (which has never been isolated), which merits the name of the specific plasma.

But among the total of living creatures the species is only a mode of classification; for every organism besides its position in the species also represents a variety, a race in the species; and through its species it forms a part of the vaster and more comprehensive groups, the Family, the Order, the Branch.

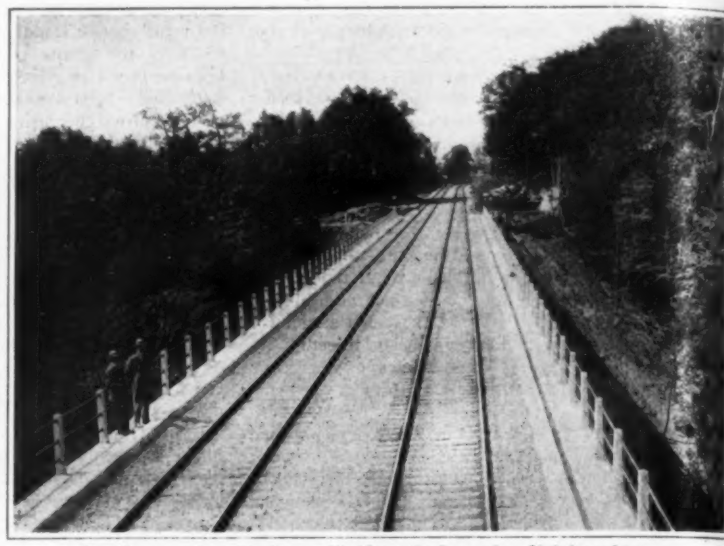
It is even possible to believe in the probability that within the bloods, the lymphs, the saps and the humors of living creatures there are mingled cellular plasmas characteristic of these various groups. . . .

We do not insist upon these generalities without noting that the animal and the vegetable kingdom have their special products in great abundance; the chlorophylls, the celluloses, the starches, the tannins, are almost solely of vegetable origin, while glycogen or hemoglobin is of animal origin; but we believe that there is a special chemism among Mammals, which alone execrete their nitrogen in the state of urea, while in the singular Bird-Reptile group united for paleontologic reasons under the name of Sauropsida, this elimination is in the form of uric acid (the Sauropsids also yield special precipitines throughout the group) (Morat and Doyon). We also believe in a special chemism in the Salachii (including the sharks and rays) since Baglioni found in the blood of these fishes a quantity of urea almost as great as that in human urine. Again there are multiple chemical differences among the Invertebrates, some of which eliminate their nitrogen as guanine, while others excrete chitine (worms, insects), and still others conchyoline (molluscs). We need not here enumerate in the vegetable kingdom the gums, mucilages, resins, oils, latex, peculiar to so many families of Phanerogams; some of these, like mannite, are found in many families; while another like sorbite is found almost exclusively in the rose family.

It was by an unexpected application of Wassermann's reaction in preparing the rabbit with human serum that Uhlenhuth obtained a definite precipitate with the serum of the anthropoid apes but not with that of the lower apes or other mammals. Likewise, Friedenthal in preparing the rabbit with the extract from the flesh of a frozen mammoth obtained a precipitate with the serum of the Indian elephant, and Schepotieff, preparing the rabbit with an emulsion of Cerebratulus Nemertinea, was able to conclude by a negative reaction with the Annelids and a positive reaction with a Platod that the place of the Nemertinea was rather with the flat worms. Similar experiments have defined

[Continued on page 327]

Reinforced concrete bridge 0.9 of the Canadian Pacific Railway, near North Toronto



Looking west on the deck of bridge 0.9 shown in adjoining view

Reinforced Concrete Trestles

Unique Viaducts Substituted for Steel Construction

In accordance with the general tendency to avoid the use of structural steel wherever possible in the present period of high prices and delayed deliveries, the Canadian Pacific Railway has now completed two reinforced concrete trestles at North Toronto, Ontario, that are excellent examples of the possibilities of reinforced concrete in bridge structures where, under ordinary conditions, steel might have been utilized. These trestles were built in connection with the double tracking of the North Toronto subdivision of the Canadian Pacific between North Toronto and Leaside Junction, a distance of two miles. They replace old single track steel trestles, are approximately 100 ft. high and are of equal length, 386 ft. between back-walls. Taken together they involve 13,500 cu. yd. of concrete and 670 tons of reinforcing steel. Work on these trestles was begun in July, 1917; one of them was put into partial service on May 1, and the other on May 10. The whole of the double track work, including the bridges, is now practically completed.

Bridge No. 1.8, located at the throat of the North Toronto yard, is a three-track trestle and bridge No. 0.9, located out on the line, carries two tracks. They cross ravines more than 100 ft. deep of approximately similar contour and width. In making plans for the structures advantage was taken of the similar conditions to standardize the designs as far as possible. To this end the spans were made equal, each trestle consisting of five towers of 34-ft. span and six intermediate spans of 36 ft. This permitted standard construction above the trestle bents, thus simplifying the building of forms for the pre-cast deck slabs and lessening the number of forms required. At the three-track trestle 66 deck-spans were required, all of which were cast in eight forms. The same number of forms was used for the 44 deck spans required in the two-track trestle.

The towers in each case consist of two bents tied together by horizontal struts. The plans show the typical bent for the two-track structure which consists of three posts tied together by a cap and transverse struts. The bents of the three-track structure are of similar design but have four posts instead of three. The footing, which is continuous under all of the posts of each bent, is designed as a girder to distribute the column concentrations to the foundation material. Under the tallest bent this footing is 53 ft. long.

The columns are of a uniform section throughout the structure. The batter columns are 3 ft. 3 in. square and the interior columns 3 ft. 3 in. by 5 ft. in section. They are all heavily reinforced. The outside columns of the tallest bent have 24 and the inside columns 36 1⅛-in. rods for a length of 34 ft., beginning at the bottom, while rods ⅞ in. in diameter are used in equal numbers in the upper sections of these columns. The posts are all hooped at intervals of 6 in. with ⅜-in. stirrup bars. The caps at the tops of the bents are of a T-design with an upper part 2 ft. 11 in. deep of the same width as the column and a lower portion 3 ft. deep of the same width as the strut, 1 ft. 10 in. The longitudinal struts are unusual in the use of recesses or panels 3 in. deep on the two side faces.

The slabs are of the pre-cast type of T-beam design with two slabs approximately 6 ft. 6 in. wide under each track, each unit consisting of a single girder 3 ft. 6 in. wide with an expanded top to form a deck slab 12 in. deep. A curtain wall at each end of the slab extending down to the bearing surface finishes the slab to a full width of 6 ft. 6 in., but this curtain wall does not assist in carrying the end reaction since the slab is supported on a steel bearing plate interposed between the end of the girder and the cap of the bent, which is only as wide as the girder. These girders embody one refinement not often seen in the paneling of the vertical faces to a depth of 4 in. on each side, a feature that improves the appearance and saves some concrete although complicating the reinforcement and the form work.

Provision for a side-walk in a structure of this kind always introduces a perplexing problem. The width of the slab, approximately 6 ft. 6 in., is determined by the spacing of the tracks while an extension of the outside slab a sufficient distance to provide a walk would introduce a serious eccentricity in the slab design, while producing an increase in weight of a slab which already weighs 51 tons. This problem was overcome in the two Toronto viaducts by building both the sidewalk and the parapet as separate units, introducing a special feature in the main slab only by the addition of four brackets to carry the sidewalk slab. The parapet units are 4 ft. 2¾ in. long and are doweled to the edges of the main slabs. The sidewalk slabs are 9 ft. 2¾ in. long.

The edge of the walk is 6 ft. 3 in. from the center line of the track, or 3 ft. beyond the edge of the main slab. As the walk slab is also of the T-design and is supported by its stem on the brackets projecting from the main slab any unbalanced load near the outer edge of the walk would produce a considerable overturning moment. This is resisted by the weight of the parapet, since the inside edge of the walk is made to fit into a groove provided in the face of the parapet. This walk also carries a railing consisting of concrete posts spaced 9 ft. 3 in. center to center with three lines of 2-in. wrought pipe.

The slabs weigh 51 tons each and interesting methods were developed for transporting them from the casting yards to the bridges and for erecting them. To facilitate the handling two vertical 2-in. holes were provided at each end of the slab, 9⅝ in. each side of the center line, for 1⅝ in. bolts. These holes were closed up after the slabs were placed. When ready for placing, a slab was picked up by a 100-ton wrecking crane, set on two standard car trucks, which were run down the main line to the bridge and switched in front of a 30-ton bridge erection car. Two timber trusses were provided, long enough to span between bents and far enough apart to take a slab between them. They were fitted with rails on the top chords to carry a traveling crane built of wood.

With the slab properly placed with reference to the erection car and the traveler, the car picked up one end of the slab and the traveler the other. The car was then moved ahead, pushing the traveler along its track on the trusses until the slab was in the proper location, between the trusses, to be lowered to place. With the slabs for one span in place, the track was laid forward over them, and the trusses were picked up by the crane and moved ahead to the next span ready to repeat the operation.

The work of building the towers was done during the winter at a time when the temperature was below freezing point; it was performed inside of what was virtually a building erected to maintain a suitable temperature around the newly deposited concrete until it was out of danger of being damaged by frost.

The Magpie—Is He Rogue or Fool?

The *insouciance*, or apparent unconcern of the lark and the swallow in the midst of war's alarms has been remarked by many nature observers at the front. Neither the blackbird nor the thrush shows this remarkable apathy; they prefer peaceful environment, and go in search of it when their privacy of peace is invaded by the sounds of battle.

The behavior of the magpie when caught in the war zone has been exercising the mind of a friend now on active service in France—a country much favored by the magpie. He is not sure whether the bird, though evidently excited by war, dislikes the excitement. At any rate it does not flit from the troubled scene.

And the larger question which puzzles my friend, after long and careful observation, is—whether the magpie is rogue or fool? It appears to be mischievously cunning, but it looks a guy, and its behavior is often as fatuous as its appearance is grotesque. "I am inclined to regard the bird," writes my friend, "as a sort of village natural in the avian community. To my mind, he never seems to be quite *all there!* He probably does not realise there is a war on. When flying he does not appear to know where he is going or how far he will get. The other birds bully him. You have a suspicion he will fall when you see him rising on a wind. His tail was not made for him; he cannot manage it; it seems a serious encumbrance as he wobbles about." As a member of the crow family (the *Corvidoe*) he is distinguished by his length of tail. It is at least as long as his body; in some instances almost twice that length. But he has the family characteristics of a harsh voice and a propensity for thieving; to which add an omnivorous appetite.

Like all odd birds, he is popularly associated with superstitious beliefs. The common Lowland rhyme (which attributes good luck to odd numbers) goes thus:

Ane's joy, twa's grief,
Three's a waddin', four's death.

The North of England variant contradicts this:

One is sorrow, two mirth,
Three a burial, four a birth.

Anglers would rather meet two magpies together than one; the weather is thought to be promising if both leave the nest. Wordsworth and Humphry Davy shared the English belief in even numbers.—J. L. R. in the *Scotsman*.

The Dumping of Government Property

"Under date of October 8 the Committee on Public Information released a bulletin in which it described a Surplus Inactive Supplies Service that had been organized in connection with the General Staff, and then went on to say that the Division of Military Aeronautics has found since August 6 a surplus of supplies, more than they could use. Most of it had been junked. It gives the essential information that in a single division alone it has a list of 1,200 different surplus items, including more than 50,000 units. This division (Military Aeronautics) has turned over the following surplus items: 150,000 gal. of oil worth $75,000; 417 typewriters valued at $25,000; 200 tons of hay valued at $3,000; parts for 3,500 French Gnome airplane motors, listed at the time they were ordered in this country by the French High Commission at $10,500,000, but which now must be sold as junk. There are 1,000 tons of these motor parts; 300 Penguin training planes worth $750,000, a type now obsolete; 128 L.W.F. airplanes worth approximately $1,427,000; 1,500 J.N.L. airplanes valued at $9,000,000, now obsolete; 500 additional motors valued at $750,000; 1,500 planes for which no suitable engine has been developed; 4,500,000 ft. of ⅜-in. rope; 500 pairs of field glasses worth approximately $37,000 (found in the supply department at Omaha); at Middletown, Pa., depot, 9,000 gal. of 'dope,' a preparation for wing fabric in airplane construction and worth $47,500. Other surplus supplies located included seven carloads of iron, steel and wood-working machinery found in a supply depot at Hampton, Va.

"If the single department of aeronautics in this time of war can publicly announce an overpurchase of these amounts, what will be the quantities the Government will have on hand when the war ends? How many motors; how many wagons; how many auto trucks; how many thousands of tons of steel, of copper, of zinc will the Government have on hand in storehouse and in transit and under contract which it has purchased and not used?

"How many thousands of tons of scrap steel in shells and ordnance, finished and unfinished; how many dredges and scows, and hoists, and concrete mixers, and excavators, and concrete machinery will it have on hand? What is to become of the millions and millions of dollars worth of machine tools that have been made and installed in Government-owned shops for the making of munitions and armament? What will become of the thousands of lathes, planers and drill presses that individual manufacturers have on hand which they have installed for special contracts to assist the Government? How many thousands of pounds of wool and cotton cloth and clothing must be disposed of? How many millions of pounds of food and canned goods, and horses and mules and camp equipment? Think of the number of desks, and typewriters and office furniture that must find a market. Will all of this surplus supply, which is practically the production of our industries for the last eighteen months, be thrown on the market in competition with the very manufacturers who produced them? The disbanding of the huge war machine in Governmental employees alone will create a problem. Will the high prices that a manufacturer now receives because of the shortage of production continue when the Government withdraws its support from these various industries and ceases to be a purchaser? Will the public consume goods at the prices which the manufacturers must receive if he pays prevailing wages?

"How can the manufacturer readjust his increased facilities to these after-war conditions?"

These are but straws that indicates which way the wind blows, and foreshadow the momentous problems of world commerce that will arise with the ending of the war, and for which no preparation has been made. Germany foresaw, and began to study these problems two or three years ago, and will be as fully organized and equipped for the commercial offensive as she was for her contest of arms. England and France also are preparing for after-the-war trade conditions, and most other countries are taking account for tomorrow; but our Government steadfastly refuses to consider these things, or to initiate any steps for the conservation of our commerce.

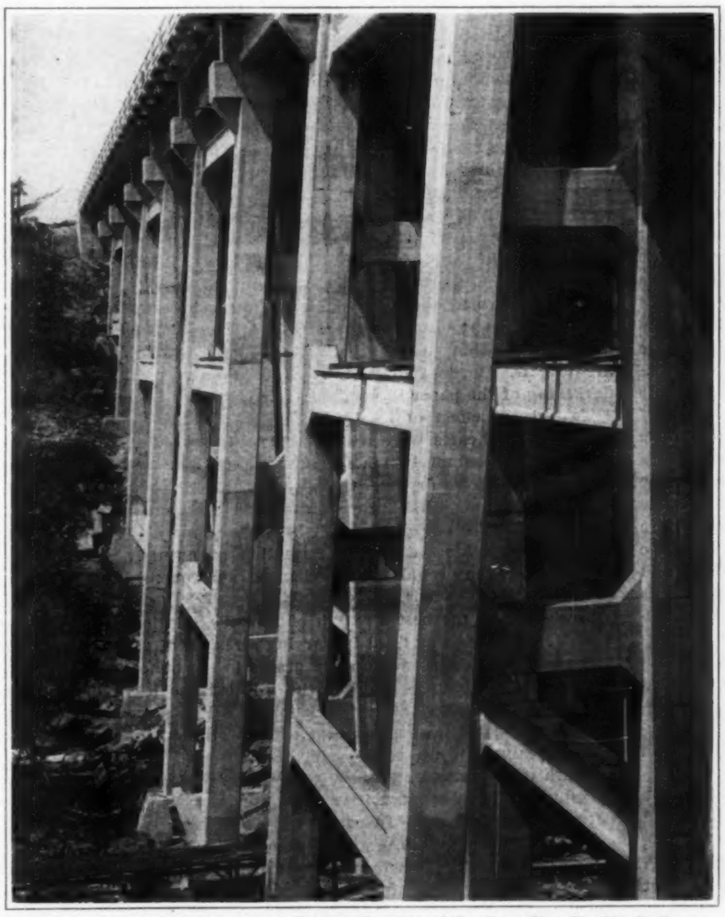
Unpreparedness for war has cost us billions of dollars, as indicated slightly by the above figures. What then may we expect as the result of unpreparedness for peace?

Some Anthropological Misconceptions

Attention was called to the cyclic nature of cultural movements and stated that like other beliefs the doctrine of evolution which so dominates the thought of our time is subject to the same law, and bound to have its rise, decline, and disappearance as an object of peculiar interest, and further, that the truth embodied in it will in time become so axiomatic that no particular attention will be paid to it and the chaff will disappear.

Unfortunately when pioneer anthropologists began to apply evolutionary ideas to their science, then in its infancy, they fell into a serious error. They assumed, with some justice indeed, that the existing peoples of the world presented features, some more and some less primitive, features which might be arranged into series showing the stages which mankind as a whole had passed through. But in selecting the "most primitive" features they worked on the false assumption that that which was most foreign to the ideas of the society in which they lived, in the cultural center of western Europe, was the most primitive. This resulted in a vast crop of pseudo-scientific evolutionary theories, each based on its author's own peculiar understanding of what was more and what less primitive. An assistant source of error was an over earnest attempt to find survivals analogous to the "vestigial characters" of biology in all kinds of cultural features, many of which were not vestigial at all. The speaker referred to several evolutionary theories of this kind, treating at some length those regarding the evolution of totemism from a matrilineal clan system, the evolution of marriage from a primitive promiscuity, and several theories concerning the origin of religion, such as those of Spencer, Taylor, Frazer, and Lang.

Secondly, the author took exception to the extreme uniformitarian attitude taken by certain anthropologists. He called attention to the fact that absolute uniformitarianism is impossible since even the inorganic world is based on discrete molecules, atoms, electrons, etc., while the organic world is based on independent organisms. In the same way when we turn to the culture history of mankind we find that ideas, although progressive, do not roll into consciousness with the even motion of a wheel, but come at certain definite times and places.



Close-up view of the towers of Bridge No. 1.8 of the Canadian Pacific Railway, near North Toronto

Along with this extreme uniformitarianism he believed too much stress had been placed on the unconscious or subconscious side of evolution in human institutions. Important as the latter undoubtedly is and much as it is neglected by the man of average intelligence, it acts less toward the development of new institutions than toward the preservation of institutions already in existence, and is accompanied by degeneration, or at most imitation, rather than by absolute origination.

In this connection Dr. Swanton took occasion to criticise a certain type of student who, because he observes the powerful effect of sub-conscious imitation, assumes that there is an extra-mental current which settles all problems, and looks cynically upon conscious efforts to bring about change. When examined closely this seemingly unconscious current would be found to be a resultant of forces, each of which was the decision of some individual or some group of individuals at a definite time and place. He believed that if any of these decisions had been different the stream itself, the course of history, would in some measure have been different.

In the discussion which followed the address Dr. Leo J. Frachtenberg agreed in main with the assertions made by the speaker. He called attention to the fact that the error of particularization is well exemplified in Westermarck's "Origin of Primitive Ethics." Dr. Frachtenberg expressed the belief that the principles of unconscious evolution should not be underestimated. Dr. Truman Michelson added as another misconception the supposition that the languages of primitive peoples indicate a low mentality, stating that it is possible to express complicated ideas by means of these languages but that the ordinary life of the people does not require such expression. Another misconception, according to Dr. Michelson, is the arranging of languages in a scale of superiority with inflectional languages as the highest point of development.

In closing the discussion Dr. Swanton stated that although it is true that the unconscious element plays a very important part in the evolution of culture, its functions are conservative or, at most, imitative, with a tendency toward degeneration, whereas the conscious element is that which creates, that which produces positive advances.—*Abstract from a paper read by Dr. John R. Swanton before the Anthropological Society of Washington. Reported in Jour. Wash. Acad. Sci.*

Chemical Utilization of Seaweed

During the last few years Swedish seaweed has been coveted by the Germans, who make it into fodder, and also use it as a source of valuable chemical products. A series of experiments, carried out with profitable results at Stockholm, have shown that by the dry distillation of 1 kilo. of dried seaweed the following products can be obtained: Illuminating gas, 30-32 liters; carbon, 43 per cent; distillates (acetic acid, methylated spirit, formic acid, acetone, etc.), 35 per cent; salts (sodium suphate, potassium sulphate, potassium chloride), 14 per cent; and, in addition, iodine, bromine, a very aromatic tar product, and carbolic tar, an excellent preservative of timber. The Focus Co. is about to start a factory at Varberg, with a yearly consumption of about 1,000 tons of seaweed, estimated to yield 20,000 cub. m. of gas, which will be used for working a gas motor to draw water from the sea for cooling purposes. On account of the scarcity of artificial manure the factory will this year produce principally sodium sulphate, potassium sulphate, and potassium chloride, for the manufacture of a fertilizer containing 37 per cent of potash.—*Svenska Dagbladet.*

Transmitting Signals Between Electric Generating Stations

In the *Revue génerale de l'Electricite* for May 18, methods are described to enable electric generating stations to transmit signals over their systems. These signals could be used for such purposes as time-signals synchronizing clocks, or giving any other pre-arranged signal, such as air-raid warnings, etc. The signals consist of a series of periodic variations of voltage, the magnitude being small compared with the line voltage.

Fixing Photographic Prints Without Hypo*

Some Preliminary Experiments with Printing Out Paper

By Dudley Kidd

As the shortage of hypo has suggested that experimenters should try new methods of fixing bromide prints, some experiments in the fixing of P.O.P. prints, extending over a year, may usefully be described, as they may suggest a line of experiment to others.

To prevent misunderstanding, a personal explanation seems called for. Being ordered by the surgeons to lie flat on my back for two years, and not even being allowed to turn on my side, I found it impracticable to fix P.O.P. prints with hypo. All I wanted was to be able from time to time to examine proofs of old negatives. To comply with the orders of the surgeon it was essential to think out the simplest possible way of fixing, or at least of depressing the sensitiveness of, P.O.P. prints. The method worked out is so simple that a finished print can be hung up to dry within a minute of its leaving the printing frame. The permanence of such a print is of a poor order; yet the photograph can be left exposed opposite a window on the mantelpiece of a room with a south aspect, and will show very little change in six months, though a few hours' exposure to sunshine will ruin it. Still, the print can safely be examined in sunlight again and again, provided these periods are not prolonged.

As several interesting points have arisen during these experiments, it may be well to give an outline of the theory that served as a working basis to start from. It is well known that silver chloride cannot exist, save in infinitesimal amount, in the presence of an excess of a soluble bromide salt. Some experiments with a different object in view had shown me that bromide of silver darkens somewhat more slowly than usual if it is soaked in a strong solution of potassium bromide. All that should be necessary, then, would be to soak a P.O.P print in, say, bromide of potassium and hang it up to dry, leaving the free bromide in the print. Thus, the absence of washing would be a positive gain. Sir W. Abney writes: "Potassium Iodide will, in the light, liberate iodine in the presence of oxygen, and this is yet more the case when it is also in the presence of metallic silver, or an unsaturated compound of silver, such as the sub-iodide; and the action of light on potassium bromide under the same circumstances is precisely the same. And we have also seen that the silver sub-salt is destroyed by iodine or bromine. Suppose we have silver bromide and potassium bromide exposed to light together: then, as fast as the silver sub-bromide is formed, it has a tendency to be destroyed by the potassium bromide, splitting up into bromine and other compounds." ("Instruction in Photography," p. 47.) Again, he writes lower down: "In a gelatine film, probably the bromine, when coming in contact with the gelatine, liberates hydroxyl or peroxide of hydrogen. This, as is well known, is a very strong oxidiser, and it will oxidise the neighboring molecule of gelatine, or else the silver sub-bromide, and so produces an undeveloped image." ("Instruction in Photography," p. 49.) Here, then, we see that, in theory, our bromide-fixed P.O.P. print will be the scene of varied changes. To start with, when exposed to light, bromine will be liberated, which will destroy the silver sub-bromide as fast as it is formed, and in the process fresh bromine will be liberated. The liberated bromine will also set free peroxide of hydrogen, which will oxidise the gelatine or the sub-bromide of silver. Will the result be a fairly stable print?

The simple method, proposed above, of fixing the P.O.P. print in potassium bromide solution, seems open, at first sight, to two objections, which have probably deterred experimenters from following up this idea. First, the silver bromide left in the print might rapidly darken when exposed to light, just as a piece of bromide paper will under such conditions. Secondly, the free bromide left in the print may slowly bleach the printed image or spoil its color. And the high-lights might also be ruined by the yellowish color of silver bromide. But experiment soon showed that all these fears were exaggerated.

A number of P.O.P prints, with white margins, were made on Ilford, Paget, Imperial, Wellington, Kentmere, Baryta, and Solio P.O.P., both in the white glossy and white matt surfaces. These were soaked for one minute in solutions of the bromides of potassium, ammonium, and strontium; the strengths of the solutions varying from one grain to sixty grains per ounce of water. On plunging a print into such solutions, the color rapidly changed to an unpleasant yellowish one, while the white margins became dirty. The prints were then hung up to dry in a dimly lighted room. When dry the margins of the print were found to be nearly as clear as they were originally. (A plain unexposed piece of P.O.P. when soaked in a solution of potassium bromide shows a very slight yellowish color.) On exposure to sunlight, the ugly yellow color of the print—on some makes of P.O.P. (Ilford and Imperial proved the best)—rapidly changed to a fair sepia.

After several hours' exposure to winter sunshine the high-lights and margins turned a mauve color, almost exactly matching the ordinary mauve-tinted P.O.P. In some cases longer exposure to sunshine actually lightened this tint, but, as a rule, the color slowly darkened till the picture was ruined. Matt papers showed somewhat greater degradation of the high-lights than did glossy papers.

The differing reactions of different makes of P.O.P. may depend in part on the amount of free silver in the emulsions. But probably more depends on the presence or absence of "sensitisers," which act as bromine absorbers. As manufacturers naturally do not publish their formulæ, one is working a good deal in the dark. Of the papers tried, Kentmere was the least suitable. Then came Wellington, which darkened quickly. Paget P.O.P. turns an ugly chocolate color, while Solio turns to a still uglier yellow that will not subsequently change to sepia. Ilford paper is the most suitable.

It is known that gelatine itself is a "sensitiser," and so experiments were tried with Ilford collodion P.O.P. The color of the printed image is a sort of crimson violet: this is unchanged by soaking in potassium bromide. But on exposure to sunshine the image slowly fades after turning a bluish color. Self-toning papers are useless, as the gold in them leads to a general darkening of the paper in sunlight.

To test the effect of leaving potassium bromide in the print, duplicates were made, both being soaked in the same potassium bromide solution; but one was well washed before drying. On all occasions the print with free bromide in it proved more stable than the washed print. Washing the print before soaking it in potassium bromide led to the formation of an ugly yellow color that could not be changed subsequently to sepia.

To determine the best strength of bromide solution, a series of prints was fixed in varying strength of solutions, varying from two to sixty grains to the ounce. It was found that the stronger the solution the less quickly did the print darken in sunlight. But since there was very little improvement after a strength of fifteen grains to the ounce had been reached, the strength was regarded as, on the whole, the best to use.

Prints fixed in bromides have now been kept in the dark for about a year. In nearly all cases there is a slight amount of fading, while in a few cases the image has largely faded out, especially where the hygroscopic bromide of strontium was used. Yet these faded prints can be re-developed with hydrokinone or Rytol just as though they were ordinarily slightly printed P.O.P. prints. They also stain as easily in the process.

When exposed to summer sunshine the bromide-fixed Ilford P.O.P. print usually gets spoiled by a general darkening in a day or two. But placed in the diffused light of an ordinary living-room six months causes but little change. At first there is a slight darkening in the color of the image, and the white margins turn to a mauve tint. But after a few months this mauve tint fades, while portions of the print protected by black paper show the once white margins to be now darker than the parts exposed to dull light. The disproportion between the effect of sunshine and diffused light is very striking, as is the relative sensitiveness of ordinary bromide paper and the bromide-fixed P.O.P. print. Bromide paper placed in diffused light will darken more in thirty seconds than the bromide-fixed P.O.P. print will in six months. Yet both consist in the main of bromide of silver in gelatine. Further, if a strip of fresh bromide paper be placed with a strip of bromide-fixed P.O.P. in summer sunshine, the bromide paper will prove to be some ten thousand times faster than the bromide-fixed P.O.P. What, then, accounts for this striking difference? Possibly it is to some small extent due to the different quantities of silver bromide per unit area. But this cannot be the full explanation. Does the P.O.P. contain some substance which depresses the sensitiveness of silver bromide? Will the manufacturers of P.O.P. enlighten us on this point? For if it were cleared up we should possibly be in the way of preparing a P.O.P. emulsion that would give really permanent prints when bromide-fixed. It must be remembered that in seeking to fix a print in this way we are, from the manufacturers' point of view, sadly abusing the perfect product he gives us.

Hundreds of experiments with dilute acids, alkalis, reducers, oxidisers, etc., have been tried, so as further to depress the sensitiveness of the bromide-fixed P.O.P. prints, yet without success. The only thing that has been even partially successful has been ammonia. If a P.O.P. print be first soaked one minute in a solution of ammonia (1 dr. of the .880 to the ounce of water), and then washed in water for a minute or two before fixing in potassium bromide, the resultant print will be more stable than the comparison print soaked only in the bromide solution. But the color is very unpleasing; in fact, the color fairly well matches that of a P.O.P. print that has been soaked in water before being fixed in potassium bromide. This seems to show that the presence of free silver in the P.O.P. tends to the production of a pleasant sepia tone.

An interesting question arises as to whether there are not two processes going on in the bromide-fixed print. When placed in a bright light the print slowly darkens; when placed in the dark it slowly fades. When placed in diffused light the two processes nearly balance one another.

As to the darkening of the white margins of the print, there are also two processes at work in the case of some makes of P.O.P. After long exposure, if the white margin be examined by a strong magnifying glass—say, 10x—minute purple-brown spots can be seen. They are obviously small darkened portions of free silver or silver chloride which have become embedded in the fibre of the paper base that here and there resists the action of the bromide. There will also be seen a general—apparently structureless—stain of a mauve tint which pervades the emulsion.

To those who wish to test this process the following method is suggested as a starting point for future experiments.

1. Print on Ilford P.O.P. glossy paper to the exact depth you wish the final print to be.

2. Take the print from the printing frame, and, in diffused light of the workroom, plunge the print straight into a solution of potassium bromide—15 grains to the ounce of water—and keep the print moving in the solution for one minute. Be sure the solution wets the gelatine, which is apt to be horny and repellent of liquid.

3. Take the print out of the solution and hang it up to dry, without blotting it off. If a really well-boiled rag is at hand the print can be blotted off. But if, say, a handkerchief fresh from the wash is used, stains are apt to be formed.

4. Dry in a dull diffused light.

5. Expose the dried print for a minute or two to sunshine, or longer to bright diffused light, until the yellowish color of the print changes to a pinkish sepia. Then keep the print from needless exposure to sunlight.

If in a hurry, it is possible to brush the surface of the print (and the back also) with the bromide solution, and to mop off the moisture with a boiled rag. But this method is not recommended, as it is apt to leave patches not fully converted to silver bromide.

Whatever may be the permanent value of this process, it presents certain immediate advantages. There are many cases where but a slight degree of permanence will meet all requirements, and where the rapidity of the process will atone for its low order of permanence. For instance, wherever P.O.P. proofs are wanted for temporary purposes this method will be found useful. Workers in oil and kindred processes frequently want proofs of their negatives to work from as a guide; professionals want to send out proofs which shall not be too permanent, and they want to send out the proofs quickly; retouchers want a proof they can place in a good light, so as to see what progress they are making; press photographers want a proof for block-making; military men want glossy P.O.P. prints in a hurry, and only need prints of limited permanence; amateurs on tour want to send home ephemeral postcards made from their negatives but have no means

*From *The British Journal of Photography*.

of washing their prints; all these and many other classes of workers who want prints quickly for temporary purposes will find their need met by this bromide-fixing process.

Those who seek new effects might try using a toned paper P.O.P. which could be fixed in potassium iodide. The bright yellow image is stable, and might suit certain subjects.

Many experiments have been tried for converting the silver image into the stable carbonate and sulphate. But the difficulty is that by the time the change is completed the image is destroyed, reminding one of the surgeon who saved the limb but lost the patient's life.

The whole subject of the darkening of silver bromide has been somewhat pushed into the background by the more pressing need of studying the developable image. A certain amount of work has been done concerning the darkening of silver bromide, as this product is needed for actinometers. It might not pay financially, but it would pay intellectually if someone would consult the library of the Royal Photographic Society and give us an epitome of the information available, with bibliographical references. Attention might also be paid to methods of fixing such an image.

Finally, one word of caution. At the present time it is impossible to get P.O.P. that exactly conforms to the usual pre-war standard. Thus a paper bought one month will not always react exactly as a sample bought previously. Neither the Ilford nor Imperial P.O.P. gives such good colors with bromide fixing as they did a year ago.

The Bio-Chemical Characteristics of Species

[Continued from page 323]

the degrees of relation between fishes belonging to the Salmonides. . . .

The group called the Race, which is less comprehensive than the Species, certainly also has its own peculiar plasma. In this connection we may recall the suggestive analyses by which A. Gautier was able to determine the formulas of the coloring matters of various growths upon our vines. . . . similar results have been obtained with the camphors and the catechines.

We may mention, too, the innumerable plant or animal parasites which flourish upon one variety to the exclusion of others, as in the case cited above of the Phylloxera. We may mention, too, the racial predispositions to certain affections which exist in the human species, such as that of the Jews to hemophilia, of the blacks to tuberculosis and their comparative immunity to yellow fever, and the gravity of scarlet fever among the Anglo-Saxons.

* * * *

Finally, and in very considerable proportion with respect to the total organism, there exist plasmas peculiar to each individual: simple soluble bodies in loose combination, more or less unstable organic compounds resulting from the chemism peculiar to each existence which merit the name of individual plasmas in so far as their proportion in the humors or the cells is compatible with the life and state of health of the individuals under consideration; the physiologic state is their limit of tolerance. They are aggregated and associated throughout life with the specific plasmas and other plasmas, and their harmonious ensemble constitutes a living creature, while their qualitative or quantitative exaggeration enters the domain of intoxication or disease. The various methods of alimentation are primary factors in these peculiarities of plasmas, and in the human species it is easy to understand how some special habit, such as strict vegetarianism, or a steady fish diet, or the habitual taking of arsenic for a long period, would finally constitute a chemism of the body somewhat different from that of the ordinary omnivorous individual: thus, an individual urological formula and an individual blood formula have been observed. Some of these variations exist even at the very beginning of life and before the new creature is able to feed itself; thus, Lapicque discovered in the human embryo that the content of iron in the liver varies from 0.10 to 0.55% (dry extract), and in the foetus of the dog from 0.11% to 0.70%.

When diseases proceeding from microbes have been cured certain intoxications confer upon the organism a special chemical condition: vaccination, for example, or, on the contrary, anaphylaxis. Specific sensitivizers of the parasitic microbes have been detected after typhoid fever, bacterial dysentery, etc., and very sensitive antibodies recognized in the echinococcuses; but we are here infringing upon pathology, which is outside the domain of the proper physiologic plasmas.

The following experiments incline Ch. Todd and R. G. White to believe that the red corpuscles of each individual have a distinct biochemical constitution: the blood of an ox immunized with the red corpuscles of other cattle undergoes a reaction by which it produces hemolysine; but a polyvalent serum resulting from mixing the serum of several immunized animals, when extracted with the corpuscles of any kind of cattle remains very hemolytic for all the individuals not closely related to the one which provided the corpuscles—even though it has lost its hemolytic power over the corpuscles of that individual. This strongly indicates the existence of family or parental plasmas, which the phenomena of the transfusion of blood have long led us to suspect. And while Carrel has shown that grafted organs do not usually survive unless the organ is replaced upon the same individual (an autoplastic graft) the success of the grafts of ovaries between sister sheep made by Voronoff, shows clearly enough that the closest family relationship likewise has a biochemical basis. . . .

In the course of individual life plasmatic alteration becomes accentuated, and represents one of the elements concerned in growing old: there is in general a loss of water on the part of the tissues and an encrusting with mineral substances. M. Maurice has observed a regular curve of diminution in the hydration of the tissues with increasing age in experiments upon the dog (15% for the hemispheres of the brain, 25% for the spinal cord, 55% for the nerves). The content of lipoids and phosphorus increase with age, and in the adult the proportion of phosphorus is greatest in the blood and the liver and still more for the nerves. In man a well studied type of these progressive alterations of individual chemism is represented, for example, by the pigmento-fatty bodies which amass themselves at a fixed place in certain nerve cells, beginning with the third year of life, then invade them progressively and in numbers until in the old man there remains only a thin protoplasmic border constricted by the fatty pigments. Can we not consider that we have in this fact the mechanism of the slow substitution of one plasma for another? This second plasma, the fatty body, is particularly easy to follow, to localize, and to characterize, since it is insoluble and pigmented. The comparison with the ordinary evolution of plant life is very obvious: the polymerization of the celluloses, lignification, suberization, and the various incrustations of plant tissues caused by age, are within certain limits a process of the same order.

* * * *

We have no intention of asserting that any of the products defined and enumerated above is a specific plasma. It is, on the contrary, quite improbable that any specific plasma whatever will ever be isolated by the devices employed in the laboratory. It is the consensus, the co-existence, the collaboration, of these various plasmatic types which constitutes life, and their physical, chemical and mechanical interpenetration is constant and fundamental. . . .

Beneath the multi-colored weft of membranes, tissues, granules and cellular details of all sorts, which, considered separately, are but dead matter, there flow and circulate substances, different in nature, but of equal value, as concerns life: these are the plasmas in the biologic sense of the word; but the definite chemical substance weighed and delimited molecularly which might be called a specific plasma, or a racial plasma, or individual plasma, does not exist so long as life lasts.

Resilient Wheels for Motor Vehicles

The *Zeitschrift des Vereines Deutscher Ingenieure*, of October, 1917, discusses a variety of resilient wheels introduced, which, while recognized as not fully equivalent to pneumatic tires for passenger cars, fulfil a useful purpose. The wheels are classed under two groups. Group 1.—(*a*) The spring wheel uses spiral springs wound from square steel and mounted radially in one or two rows between cups secured to the inner and outer wheels. There is risk of the springs being displaced when running over obstacles or round corners, particularly at more than moderate speed. (*b*) The Moll wheel is of similar construction, except that side plates are used to protect the springs from dirt, and telescopic tubes are used inside the springs to prevent lateral displacement. These tubes are extended as spherical end caps, which give the requisite degree of transverse flexibility. (*c*) The Fruth wheel uses a series of oval springs placed on their sides in troughs attached to the outer and inner rims. Bolts through the troughs pass through the overlapping loops of consecutive springs. The wheel is rather less flexible radially, since the springs are compressed in the plane of their winding instead of axially. One of the troughs slides in the others, and so takes up transverse forces. The construction provides circumferential flexibility against accelerating and braking forces. The whole can be mounted as a unit in place of a rubber tire. (*d*) The Sievert wheel retains rubber or similar material for elasticity, and uses a wooden road rim. A rubber ring is held on each side of the fellies by through-bolts, which also secure steel side rings carrying the outer wooden rim clear of the inner wheel. All wear comes on the wooden rim, and the only connection between this and the inner wheel is through the rubber side rings. These are rather flexible and liable to slide-slip. Group 2.—(*a*) The Siemens and Halske wheel uses radially mounted spiral springs (imperfectly protected against dirt and transverse forces) and a flexible outer rim. The outer rim is built up from strip steel wound to form a hoop, which is secured by clips and protected by renewable sections of leather or similar material held by rivets. (*b*) The Flohr wheel is similar, save that the outer rim has steel links (resembling link belting), the pins of which serve also to carry cups for the radial spiral springs. The rim pins are exposed to dirt and moisture.

Cork Slabs from Cork Waste

Slabs of considerable strength may be made by compressing ground cork waste and heating it at 160 to 180 degrees C., while under compression. No binding agent is required, and it has been suggested that the natural resin of the cork serves as a binder. Various samples of ground cork were extracted several times for 24 hours with alcohol and with chloroform in the cold. The maximum amount of the united extracts, in the case of cork dust, was 9.35 per cent of the air-dry weight. Higher results were obtained when water was also used, *e. g.*, up to 10.3 per cent, since the tannins are also extracted, but water has an injurious action on the cork substance. The extract was resinous and began to melt at 150 degrees C. Equivalent weights of comparative samples of natural and extracted granulated cork were compressed to form plates of various thickness, then heated in the moulds for about 3 hours at 180 degrees C. or for 15 to 20 hours at 160 degrees C. At the higher temperature a slight browning of the cork substance was observed, but at 160 degrees C., in spite of the longer time, there was no perceptible decomposition. Tensile tests were made in a cement-testing machine; the strength depended on the degrees of compression and the heating. The more favorable results with plates compressed under 7 atmos. varied from 6 to 8 kilos, per sq. cm.; some very heavily compressed plates showed 14 kilos. per sq. cm. The plates from the extracted cork were only slightly inferior to those from the natural cork. The resistance to water and steaming was almost entirely a function of the temperature of heating while under compression; plates heated at 50 to 100 degrees C. readily disintegrated, while those heated at 180 degrees C. were the most resistant. Heating before compression was useless. The compressed plates adhered firmly to the walls of the mould, but pieces of tissue paper placed between prevented this adhesion and showed no oily or resinous stain. The author concludes that resinous extractive matters play no part in binding the compressed plates, but that their solidity depends on an interlocking or felting of the cork cells. Without heating, the elasticity of the cork is restored by steaming and the plates fall to pieces, but at 160 to 180 degrees C. incipient decomposition destroys the elasticity and the felting of the cells is permanent and rigid.—*Note in J. Soc. Chem. Ind. on an article by H. Ost in Z. angew. Chem.*

Stellite

The name "stellite" is derived from the Latin word *stella*, a star, because when the alloy is polished it takes a beautiful silvery color and luster. The first experiments in the development of stellite were made for the purpose of combining metals to make an alloy that would be sufficiently hard and that would have the strength to stand up under heavy cuts. Although, at first, there was some difficulty in obtaining the strength and getting a hard cutting edge, these experiments showed that chromium, cobalt and tungsten of which stellite is made could be alloyed in such a way as to give the desired results. In 1912 these experiments culminated in the perfected laboratory production of stellite.

Stellite is an alloy of these semi-rare metals, but contains no iron and therefore cannot properly be termed steel. The binary alloy, consisting essentially of cobalt and chromium, can be forged with difficulty at a bright red heat, but when it becomes cool its hardness remains as great as before the first heating. Stellite does not get harder as it gets hotter, but it gets tougher and holds the cutting edge longer. Cobalt is not affected by heat up to about 1,900 degrees Fahr., and the tungsten and chromium are not affected by any heat up to 2,600 or 2,800 degrees Fahr. It is clear, therefore, that the cobalt becomes tougher up to the degree of softening, but at the same time the other two metals are not changed. This makes a closer and tougher bond, allays all chance of crumbling and makes the tool last longer because it has the necessary strength to take off a heavy cut without breaking.—*The Iron Age.*

The Roadrunner

Now Said to Be the Friend of Men

A slandered reputation has been redeemed. The Roadrunner, one of the queerest and most interesting of the birds of California, has now been declared by the University of California to be a friend and not an enemy of man.

This picturesque bird, which can run as fast as a horse, has in the past been accused of destroying the eggs and young of the quail. Dr. Harold C. Bryant has rescued the reputation of the roadrunner.

Eighty-four stomachs of roadrunners were collected in southern Calofornia, during eleven different months for the California Fish and Game Commission, and the contents examined by Dr. Bryant. This search, and extensive inquiry, failed to find any evidence that the roadrunner destroys the eggs of other birds. It was found that 90 per cent. of the contents of these eighty-four stomachs was insects and other animal matter, and only 10 per cent. vegetable material, nearly all of that being fruit and seeds of the "sourberry," with some cactus seeds. Grasshoppers and crickets made up 37 per cent. of the food, beetles 18 and cut-worms and caterpillars 7 per cent. and there were lesser quantities of cicadas, ants, bees, and wasps, while scorpions made nearly 4 per cent. of the food. Spiders, trantulas, and centipedes too had been devoured.

It takes nearly two quarts of food a week to satisfy a roadrunner's appetite. Here is what Dr. Bryant found in the stomach of a single bird: two sumac seeds and one other seed, two blades of grass, seventeen beetles of four different species, eight wireworms, twelve grasshoppers, one potato bug, nine other bugs of two species, a spider egg-case, a scorpion, and a lizard.

Astonishing feats of swallowing are performed by the roadrunner. It destroys more hairy caterpillars than any other California bird—even the woolybear caterpillar, which few other birds will tackle. One roadrunner was found which had swallowed a horned toad an inch wide, another whose stomach contained four full-sized whip-tailed lizards. One taken in Arizona contained a garter snake twenty inches long, and one from California had several young rattlesnakes. With this highly spiced diet, the roadrunner seems to need little water, thriving in the hottest deserts, and in captivity rarely drinking more than twice a week, and never taking a bath—except in dust.

A thorny shrub or a cactus is the home selected by the roadrunner for its nest, and it hops nimbly from limb to limb of its thorny fortress. Husband and wife take turns covering the eggs. From three to nine eggs are laid, at intervals of several days, but incubation begins when the first eggs are laid. William L. Finley, the naturalist, a graduate of the University of California of 1903, and his wife, well-known writers on bird-life, describe a single nest in Arizona which contained one fresh egg, one egg just ready to hatch, two featherless, greasy, black, and hideous young roadrunners, and two young ones about ready to leave the nest.

Most of the California roadrunners dwell in desert regions, far from the haunts of man. While many song-birds have a range of but a few acres, the roadrunner has a range of many miles. Dr. Bryant thinks that the roadrunners in California are comparatively few in number, and even in desert regions, where they are most abundant, do not exceed ten or twelve to the square mile. In early days in California the bird was often kept about the house and garden and used as a destroyer of insects and mice, and people found it a most amusing and interesting pet.

"It is to the interest of every citizen of California," concludes Dr. Bryant, "to protect carefully this most curious and interesting bird."

The California roadrunner

The Treatment of Malaria*

The treatment of malaria has engaged the attention of the medical department of the War Office since the outbreak of the war. So soon as cases of this disease began to return to England malaria hospitals were opened, and in certain large hospitals special wards were set apart so that all patients could be concentrated and treated by physicians with special knowledge of malaria. This branch of the medical work was placed under the supervision of Col. Sir Ronald Ross, K.C.B., F.R.S., consultant in malaria, War Office, and an interim report now published by this officer gives the results of treatment of a number of cases in four of the hospitals under his control up to the date of publication.

Before commencing treatments, 193 patients who had previously taken quinine, but who had recently discontinued the drug, were observed without further medication with the view of determining approximately the liability to relapse without further treatment. Of these 193 patients, 88 had relapses within twenty-seven days. Owing to illness (unfortunately not specified), 76 had to be given quinine without continuing the control. After a month, only 15 per cent. were free from relapse, and were considered well enough to be discharged; 85 per cent. were still showing symptoms of the disease.

Two thousand four hundred and sixty cases of malaria were treated under one or other of the following methods:

(a) Anti-relapse Quinine Prophylaxis.—Quinine sulphate in small doses by different methods up to 60 grains weekly was given to 1,040 cases. A dose of 10 grains daily was found to be more effective than one of 15 grains, because, as well as being equally effective, it was better tolerated. Under these treatments relapses were reduced to 10 per cent., and even in relapses not so reduced the severity of the paroxysms was diminished.

(b) Short Sterilising Treatments.—Large doses of quinine sulphate, hydrochloride, or bi-hydrochloride were given daily for seven days, or on consecutive days up to ten days, to 334 cases. A high percentage of these cases relapsed.

(c) Long Sterilising Treatments.—Large doses of the same salts of quinine as in treatments *(b)* were given daily over long periods, continually, or on consecutive days, or at intervals of several days. Some of these treatments appear to have given the best results, especially the three treatments *(c)* 15, 16, and 17. Two of these were combined in the later stages with iron and arsenic. It may be noted that, in the experience of some observers, much intolerance is shown during the large dosage as here used, without more appreciable diminution of the number of relapses than results from less heroic lines of treatment.

(d) Mixed Treatments, including the administration of drugs other than quinine in the combinations generally used, were given in different doses for varying periods. The drugs used were tartar emetic, acid arsenoids, sodium quinine sulphonate, ethyl quinine hydrochloride, and collosol quinine. Only a few cases were treated with each drug, as nearly all those relapsed.

Sir Ronald Ross points out that he has not noticed any marked superiority in the oral, intramuscular, or intravenous methods of administering quinine. He advises that a much larger number of cases should be controlled before the efficacy of any particular drug over others can be determined. Obviously it is necessary to observe cases carefully for a much longer period than twenty-seven days after they leave hospital before it is possible to decide what is the actual liability to relapse.

A generous diet is recommended during treatment, with a little stimulant in the form of beer or wine. Opinion seems divided as to whether patients should be kept in bed or not during treatment.

A second paper expressing the opinions of medical officers in the Salonika area as to the value of prophylactic quinine and on the treatment of malaria under different conditions of service was afterwards read by Sir Ronald Ross before the Society of Tropical Medicine. Of 111 officers interrogated on the prophylactic value of quinine in 10-grain doses twice weekly, their opinions were divided, the majority holding that it was detrimental. For treatment in an advanced dressing station for three days, one officer considered that quinine should be given in 80-grain doses daily. The majority (about 63 per cent.) were in favor of 30 grains daily.

For treatment after return to duty subsequent to the above, nine officers advised stoppage of all quinine; seventy-three considered that the drug should be continued for from one to three and a half months in daily doses, according to different opinions, of 10, 20 or 30 grains. Some recommended gradual reduction of the amount of daily quinine during the same period.

In treating cases following discharge from hospital the treatment advised was much the same, the medical officers expressing the same opinions practically as for cases leaving dressing stations. Subsidiary treatment was recommended by some. Continuance of quinine until the end of the malarial season had also some supporters.

Both these papers include an account of a large amount of work done by many skilled officers, and should serve as a valuable guide to officers and medical men who have charge of malarial cases or intend carrying out further investigation work on this very important subject. It is desirable that an effort be made to ascertain definitely why quinine, so successful in the majority of cases, should fail in others.

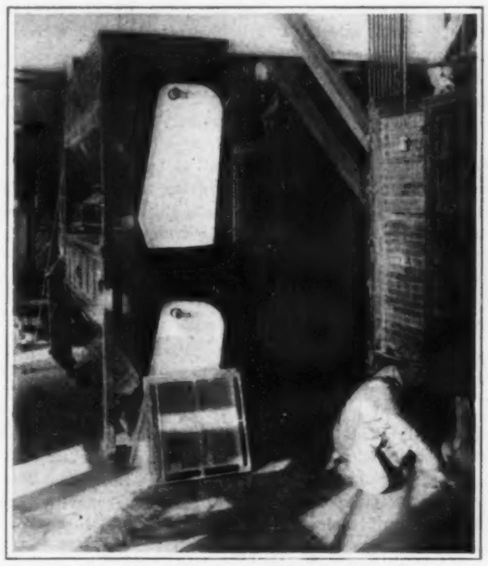
An interesting addendum to the first report deals with the excretion of quinine in the urine. It seems that there is a tendency for the excretion of quinine to reach a concentraction of 7-11 grains per litre of urine. These results obtained no matter what salt was given or how administered, except perhaps, in the case of the lactate.

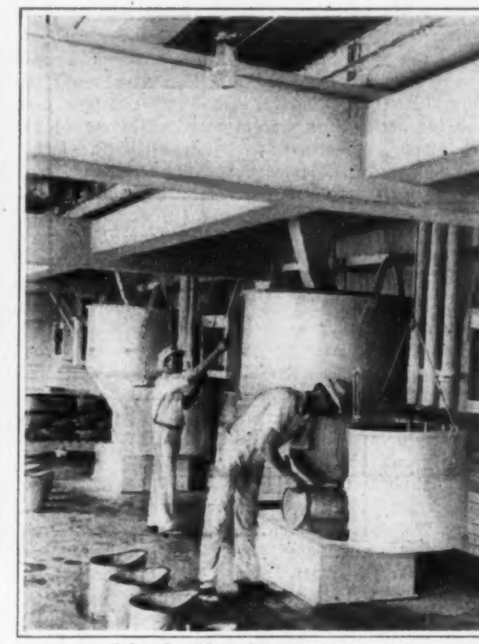
*Society of Tropical Medicine. (1) An Interim Report on the Treatment of Malaria. (2) Report on a "Discussion on the Treatment of Malaria." Both by Sir Roland Ross.—*Nature.*

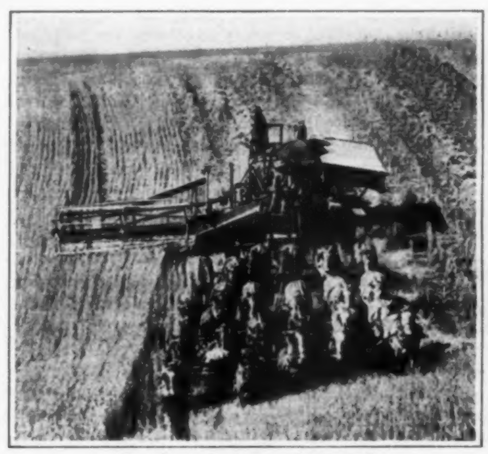
Intensification of Flat Negatives

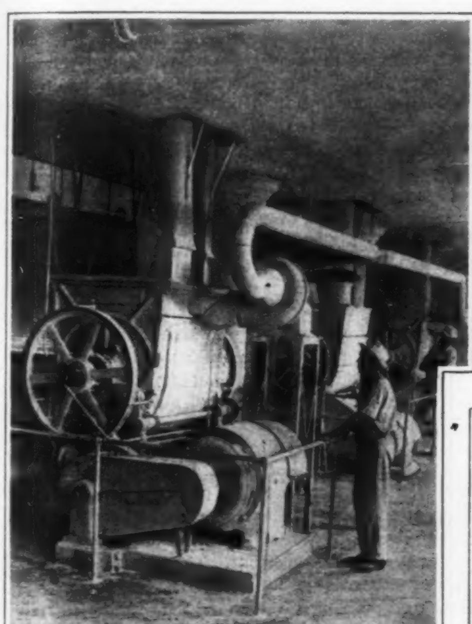
The Italian journal *Progresso Fotografico* contains a suggestion of Professor Namias for dealing with negatives which require considerable improvement of contrast. The method is one which is deserving of mention, inasmuch as it utilizes intensifying solutions in common use, and yields a result which should not be open to objection on the ground of impermanence. The negative is first only partially bleached—only to the half-tones—by a very short application of a bleaching solution as used for the chromium intensifier, *i. e.*, Potass bichromate, 2 gms., hydrochloric acid, 5 c.c.s, water, 1,000 c.c.s. As soon as the half-tones only have been bleached, as judged from the back of the plate, the latter is well washed, immersed in a bleaching bath of mercury bichloride until fully whitened, and again well washed. It is then redeveloped in full daylight until thoroughly darkened through to the glass side. The *rationale* of the process is the conversion of part of the image into silver chloride, and of the remainder into silver-mercury chloride. The former is simply restored to metallic silver, but the latter to metallic silver and mercury.

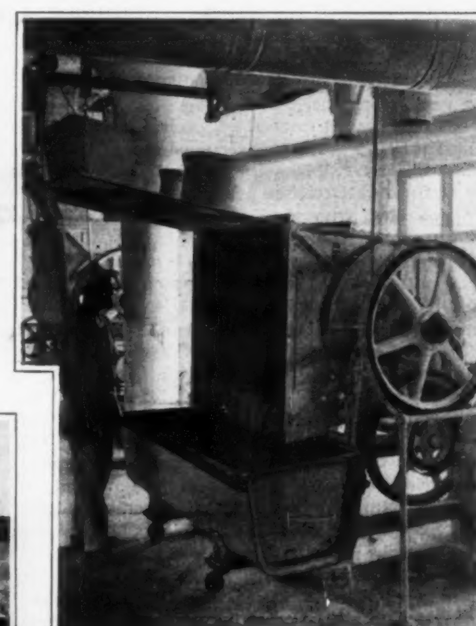

Roller mills that grind the wheat


Then the flour is sifted by machinery

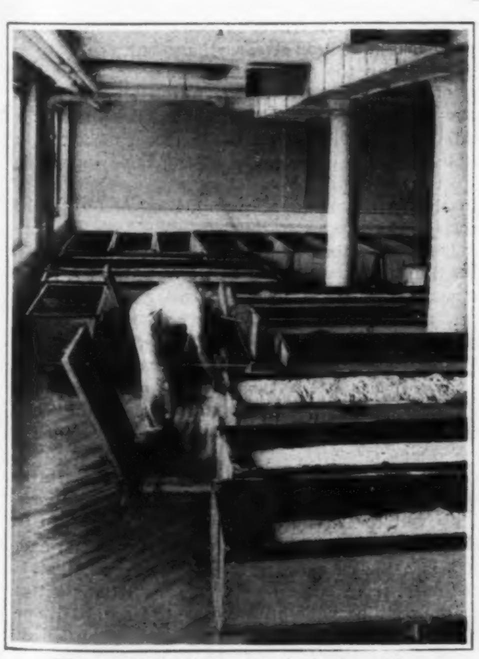

A batch of bread is measured out


Reaping wheat on a big ranch

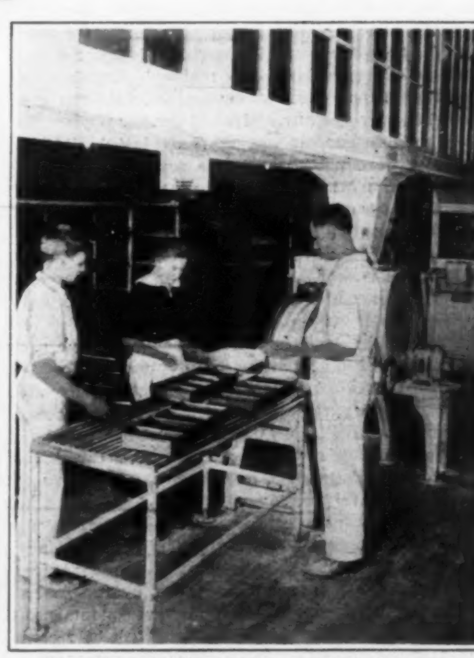

These machines mix the dough


Dumping dough from the mixer


How the small farmer cuts grain


The raised dough goes to the loaf machine


From the oven come crisp brown loaves


From the moulding machine to the baking pan

THE STORY OF WHEAT FROM THE FIELD TO THE TABLE TOLD IN PICTURES

Big American Guns in France

RECENT reports of the operations of the American army in the Meuse region in France have mentioned the work done by some big American naval guns in shelling important German bases and railways far behind the battle lines, but information in regard to the character of those monster batteries has been lacking. The story of this remarkable episode in American enterprise has now been released by the authorities; and the following is an abstract of an account that has appeared in *The Army and Navy Journal.*

The enterprise of the United States Navy Department, and particularly its Bureau of Ordnance, in building 16-inch naval guns, transporting them across the Atlantic, together with their full accessories, and mounting them on specially designed railroad carriages for service in battering German army positions, stands out as one of the greatest mechanical achievements of the war. These great guns throw a heavier projectile and have a greater muzzle velocity than any guns ever previously used as railroad artillery.

The final plans and specifications for the construction of 16-inch guns which were prepared at the Naval Gun Factory, Washington, were completed in less than thirty working days, being ready for submission to the bidders about January 25, 1918. Large mounts were to be built, capable of taking these big calliber guns, each mount with its accessories to be operated as an independent train. The equipment included locomotives, gun cars, ammunition cars, crane cars, construction, sand, timber, berthing and kitchen fuel, workshop, and staff radio cars, cars for officers, battery headquarters and miscellaneous purpose cars. The first gun, mounted complete, left the Baldwin shops on April 25, 1918, for the Army proving ground at Sandy Hook, where tests were made.

These guns are all manned and operated by officers and men of the U. S. Navy, under the command of Rear Admiral Charles P. Plunkett, former Director of the Office of Gunnery Exercises and Engineering Performances. The first party of officers and men for this expeditionary force arrived in France June 9; the first shipment of material left the United States on June 20, and the entire organization was completed and ready to move to the battle front in France late in August. This group of 16-inch guns was in action at the front for the first time on September 16, and has continued in active operation since that date.

These guns were originally intended for the new battle cruisers, but a change in the design of the cruisers left the guns available for other use. Rear Admiral Ralph Earle, Chief of the Navy Bureau of Ordnance, recommended that they be placed on railway mountings for land service with the armies in France, and he was directed to proceed with the design and construction. To make the guns completely mobile it was necessary to provide not only the railway cars for mounting them, but also locomotives and cars sufficient to accommodate all the operating personnel of the expedition, together with the ammunition, repair shops, cranes, stores and miscellaneous material.

A form of pit foundation is provided to enable the guns to be fired at high angles of elevation. Restoration to complete mobility is but the work of a few minutes. The entire mount is covered with armor plate, 1,600 square feet of plate being required. By shifting the position of the gun-mount on the tracks the gun can be brought to bear on any desired target.

When the first gun car was completed last April, gun and mount were put through the severest tests and showed accurate fire at much longer ranges than had ever before been possible with projectiles of such large size. There was then only one proving ground in the United States, that at Sandy Hook, N. J., owned by the War Department, capable of permitting ranging at extreme distances, and this was, on request of Secretary Daniels, utilized for the proving tests.

The car equipment is unusually complete. One car is a complete machine shop with every facility for repairs, with blacksmith forge and anvil, lathes, shapers, grinders, and drill presses. Ammunition cars are heavily armorplated. The kitchen cars have complete cooking and serving apparatus; the berthing cars have folding bunks for the men, and other cars carry complete sets of spare parts.

Every effort was made to secure rapid construction. The Baldwin Locomotive Company built the engines and the Standard Steel Car Company, the box cars. The huge steel girders were fabricated by the American Bridge Company. Work at all these plants proceeded night and day and was completed in record time. Many of the important parts of the gun mounts were made at the Naval Gun Factory, Washington. As soon as manufacture was well under way, the task of assembling and training personnel was begun. Rear Admiral Plunkett was placed in charge of the expedition, and under his direction the force of officers and men necessary was built up. The officers were drawn both from the regular Navy and Naval Reserves, and the men, for the most part, were taken from the Great Lakes Training Station, Chicago. Training was carried on intensively. The men responsible for the work of erection and operation of these mounts in France were trained by employing them as inspectors at the various plants actually manufacturing the material for the project, so they became thoroughly familiar with every part. The men serving the guns in action were trained at the naval proving ground. Others were given training at Sandy Hook, in the installation of the pit foundation, also in essentials of railroading necessary in the operation of the guns.

We might state that some idea of the great power of the Navy 16-inch gun may be had when it is compared briefly with the Navy 14-inch gun. This latter gun has a length of fifty-three feet six inches, and fires a projectile weighing 1,400 pounds, with a range as at present mounted aboard ship of some fifteen land miles. Its extreme range is about twenty-five miles. The 16-inch gun mounted on mobile railroad trucks, with its increased muzzle elevation, has a range said to be approximately between twenty-seven and thirty miles. It fires a shell of 2,400 pounds.

Rear Admiral Charles P. Plunkett, U. S. N., who is at present in France, in charge of the operation of the 16-inch guns, several years ago advocated the building of 18- and 20-inch Navy guns. The 15-inch guns of the British battleship Queen Elizabeth fire a shell weighing 1,920 pounds. The 16-inch gun of the United States Army uses a projectile weighing 2,400 pounds with a powder charge of 666½ pounds. It weighs 130 tons. The German cannon which threw shells into Dunkirk, France, from a distance of twenty-one miles, was a Navy 15-inch gun. It was built at Essen and fired a projectile weighing 1,675 pounds.

The first armored train with railroad artillery of which there is any detailed official description, we believe, is that used by the British in their operations in Egypt in 1882. Two armored trains were employed in the campaign in Egypt, one at Alexandria, and the other on the Ismailia and Tel-el-Kebir line. Both were rigged and operated by seamen from the British fleet. The largest of these guns was a 9-inch, 12-ton muzzle-loading rifle. The truck was left free on the rails, the recoil of the gun being thus converted into a retrograde motion of the truck.

The value of naval guns ashore was well illustrated in the Boer war, when, owing to the ingenuity and enterprise of Captain Scott, of the British navy, high-powered naval guns were dismantled from a battleship at Cape Town, mobile gun carriages were improvised, and the guns taken overland to Ladysmith after great difficulty. Their superior power saved the place in the long and memorable siege until relief came. The guns were manned by British seamen and when Ladysmith was finally relieved almost the last round of ammunition for the navy gun had been expended.

The Choice of a Lens*

A GLANCE at the advertisements of lenses reveals a perfectly bewildering number of types among which to select: or, at any rate, a bewildering number of names. The actual patterns are fewer, as in many cases the same design appears under a variety of names: but even allowing for this there are still very many quite distinct forms. Most of the differences resolve themselves into various ways of getting the same result: and, given equally good workmanship, there may be extraordinarily similar optical qualities, although the construction of the instruments may be altogether dissimilar.

If there is one thing which impresses itself more than another upon the photographer in the early stages of his photographic career it is the importance of having a good lens. He is, therefore, very much puzzled when he comes to make a selection and finds so wide a field among which to choose. He very naturally tends to attach importance to the selection of the right pattern; whereas he may be unaware that, as far as its influence upon his results is concerned, focal length and rapidity play a much greater part than design. Quality of workmanship is a factor which must not be overlooked, especially for hand camera work. For stand camera photography, in which, generally speaking, great rapidity is not important, quality of workmanship is not so necessary. One naturally likes to have as perfect an instrument as possible; but, rapidity apart, very good results can be got from very poor lenses.

Most modern anastigmats are best described as "Universal" lenses; that is to say, they are suitable for all round work; the days of the specialist lens being over, except in a few very restricted cases. Thus the "portrait lens," so-called, was particularly suitable for portraits, only because it was much more rapid than its contemporaries, working at f/4 or f/5 as against f/8 or f/11. Nowadays a good many anastigmats, which are not specifically called portrait lenses, work at as large an aperture; while, at the same time, the great increase in the sensitiveness of our materials has done away with much of the need for extreme rapidity in the lens for portraiture. So that the most rapid lens finds its greatest use on a hand camera; while many portraitists employ lenses which do not work at a larger aperture than f/6 or f/8, sometimes much smaller than that.

The "rapid rectilinear" took its name from the fact that at the time it was introduced, working at f/8, it was the fastest lens which gave an image free from any bending of straight lines ("rectilinear"). Today every anastigmat, except a few single combinations, is rectilinear, as a matter of course; and nearly all are more rapid than f/8. They are therefore quite suitable for all the work for which the rapid rectilinear was specially employed.

There was also the "wide-angle rectilinear," which worked at about f/16, but included a very wide angle. Many modern anastigmats can be used as wide-angle lenses by employing them on plates which are larger than those for which ordinarily they are used; since they have the ample excess of covering power needed. The rapid rectilinear was not a wide-angle lens; merely because, when used on a larger plate, the image did not extend up to the corners, which were therefore left blank. Whereas in many types of anastigmat there is this reserve of covering power for use when required; or, if we do not wish to use a larger plate, we may have as a wide-angle lens an anastigmat made for a smaller size than that which the camera takes.

The wide-angle quality, also, is no longer in such great demand. Photographers today are more particular in the matter of perspective; and, although if one is limited for room, a wide-angle lens is just as necessary as ever it was, if we are to photograph the subject at all; there is, among amateurs at any rate, who can pick and choose their subjects, much less tendency to photograph those which require a wide-angle lens. A few years ago such a lens formed part of the equipment of every photographer who could afford more than one instrument; now it is met with much less frequently, and a great many workers get along quite well with a camera on which they could not use a wide-angle lens if they had it.

With the exception therefore of lenses for quite special purposes, such, for example, as soft-focus lenses, telephoto lenses, etc., the choice of a particular pattern is not what is important. The points to consider are its focal length and its rapidity.

It is recognised now that, for pictorial work at any rate, a comparatively long focus is advantageous, as it gives us a more pleasant and natural-looking perspective. Not that we cannot get precisely the same perspective with a lens of short focus, used from the same standpoint, by trimming down the picture; but that the long focus lens gives us that picture on a larger scale, covering the whole of the plate, whereas the lens of short-focus gives it on a small scale in the centre of the plate, and at the same time includes a great deal more all round, the inclusion of which in the picture is the cause of the objectionable wide-angle perspective.

In the past, one often came across advice to the effect that the focus of the lens should be approximately equal to the diagonal of the plate. This gives about 8 in. for a half-plate, 5¼ in. for a quarter-plate, and so on. The angle which is then included is a very convenient one for all-round work; but, as opinion goes today, the focus is distinctly on the short side. We know several leading hand camera workers who never use a lens of less than 7 in. on a quarter-plate, and the popularity of such instruments as the Telecentric indicates that a good deal more than this is quite common.

One result of this tendency is to level up lenses in quality. A nine- or ten-inch rapid rectilinear of good quality will cover a quarter-plate crisply right up to the edges just as well as a high-class anastigmat; and, if f/8 is a big enough aperture for the work that is to be done, there is then no need for anything better than the rectilinear. When we come to lenses of five or six inches focus for a quarter plate, then we find at once that the definition of the anastigmat towards the corners of the plate is much better than that given by the rectilinear, unless this is much stopped down, say to f/22 or even more.

(Continued on page 335)

*From *The Amateur Photographer.*

Correspondence

[*The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.*]

"The Ether Ball"

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

THE assumption made in the article of the above name (SCIENTIFIC AMERICAN SUPPLEMENT, May 18, 1918), that the mass of the aether is limited, and forms a huge ball, is opposed by no known facts, so far as the present writer is aware; but neither is there anything which supports it. This is the trouble with such speculations—there is an infinity of possibilities, and there is nothing to render one any more likely to be true than any other. The writer cannot accept pragmatism, at least as he understands it, but he does think that in the present state of scientific knowledge this would be a good place to practise it. Of course, a distinction is to be drawn between speculations of this nature and the logical investigation of legitimate problems connected with the aether such as are treated of in LARMOR'S "*Aether and Matter*" (Cf. the introduction to this work, especially pp. vi-viii); but as the writer emphasized in his former note (SCIENTIFIC AMERICAN SUPPLEMENT, August 3, 1918) the tentative conception that matter is some kind of modification of the aether is all that is necessary in the present state of science; likewise, *at present*, it does not seem worth while to speculate about the distribution of the aether of space, with no way of judging the relative merits of each of the equally probable possibilities. Now in the mathematical theory of electricity and magnetism, assuming the surrounding medium to be the seat of the influences, there is also an infinity of possibilities, but of these, one is so much more probable than any of the others that it was unhesitatingly adopted by both MAXWELL and FARADAY, and proved to give highly satisfactory results (Cf. JEANS, *Electricity and Magnetism*, 3d. ed., p. 2).

Therefore, in the present state of knowledge, it seems that all that is desirable or possible is the incomplete, tentative, general, conception of space in general as an ocean of aether, of an electromagnetic character, the medium for the propagation of electromagnetic disturbances, with here and there modifications known as matter. As to the existence of the aether: "an ether was called into being solely for the sake of furnishing a carrier for electromagnetic waves, and it obviously stands or falls with the existence of such waves *in vacuo*, and this has never been questioned, so far as I am aware" (MILLIKAN, *Radiation and the Electron*, SCIENTIFIC AMERICAN SUPPLEMENT, July 27, 1918); this is a more powerful argument than that arising from the question of "action at a distance"; so far as this is concerned, even those who regard the aether as indispensable admit that it is not the only possibility; RICHARDSON (*Electron Theory of Matter*, p. 14) says: "There is no *a priori* reason for adopting one view rather than the other, although most of the great investigators have been ranged against the action at a distance school. The great advantage of the medium view is that it pictures the operation of a mechanism whose consequences must foretell themselves, whereas the other is mere dead description . . . There is no absolute contradiction between the two views. . . . Which we take as the more desirable is largely a matter of taste or convenience." *If the "action at a distance" argument is upheld, this effectively precludes the possibility of a granular or atomic aether, as has been pointed out by Stokes (Smithsonian Report, 1893).* In spite of many assertions to the contrary, the principle of relativity has nothing to do with the question of the existence of the aether (MILLIKAN, *The Electron*, p. 219; WOOLARD, SCIENTIFIC AMERICAN SUPPLEMENT, July 28, 1917). However, this principle together with other facts, such as MAXWELL'S system of equations characterizing the aether and his emphasis of the electric and magnetic forces as stresses and strains in the aether, does indicate that the aether does not *necessarily* have to have a *concrete* existence—it may be only a very useful hypothetical reference frame, such as are meridians and parallels on the earth's surface, by means of which conditions in space may be described; if, as seems likely (see e. g., CREHORE, *Mysteries of Matter and Energy*; RICHARDSON, *Electron Theory of Matter*; et al.), gravitation is electrical in nature, then these ideas would fit in with the "generalized" relativity theory in which gravitation becomes almost a property of space; this theory is not being very well verified by experiment, however, and is open to question on account of the many tacit assumptions involved in the Equivalence Hypothesis (see SILBERSTEIN, Phil. Mag., July, 1918. A General Relativity theory without the Equivalence Hypothesis). There has been a feeling that stresses and strains in the aether have bee a bit overworked (e. g., MILLIKAN, *The Electron*, pp. 16-19); and there is, as stated above, the fact of the actual existence of electromagnetic waves; the longest Hertzian waves pass over into statical electrical fields. It is hard to see how one can get along without the assumption of a continuous, all-pervading aether of space. There is a growing conviction that the explanation of the quantum theory must be sought for within the atom (MILLIKAN, Radiation and the Electron, SCIENTIFIC AMERICAN SUPPLEMENT, July 27 and August 3, 1918).

Because of the unsatisfactory extent of our knowledge, however, this assumption by no means removes all difficulties. Specific criticism of "The Ether Ball" may begin here. The author of that article, apparently in common with other speculators in this field, does not seem to realize that the modern theories of matter and energy require the aether to be ELECTROMAGNETIC in its nature; the dynamical aethers never were satisfactory, but in former days, before the modern discoveries of the nature and structure of matter, the tendency was to explain everything in terms of mechanics; we now know that electrodynamics underlies mechanics (L. PAGE, Amer. Jour. of Sci., July, 1918; NUTTING, SCIENTIFIC AMERICAN SUPPLEMENT, May 11, 1912).

The aether may possess some of the properties of matter, but it is not matter itself, nor, in the sum total of its properties, at all analogous to matter; the article under consideration, like the one (SCIENTIFIC AMERICAN SUPPLEMENT, June 29, 1918) criticised in the present writer's former note, attributes practically all the properties of ordinary matter to the aether; likewise, "temperature" plays a considerable rôle in the theory; it is difficult to picture this; the aether may or may not be sufficiently like matter to have "temperature" as we ordinarily understand the term; the writer does not see how it can have; and temperature at any point in space is meaningless (FABRY, Remarks on the Temperature of Space, SCIENTIFIC AMERICAN SUPPLEMENT, June 8, 1918); as noted before, to define a new kind of temperature which would produce the desired results would be an unnecessary complication. If the aether does end somewhere, that there is some kind of difference in the electromagnetic or other properties of space is probably true, but just what the results would be cannot be stated; in order to make his hypothesis work, JOHANNSEN assumes the aether to obey the laws of ordinary gases:

Now the aether *cannot* possibly have the constitution attributed to it in this article; even granting it to be gaseous, even granting it to be granular, still, in the words of MENDELEEFF, "the conception of the ether as a limiting state of expansion of vapours and gases cannot sustain even the most elementary analysis; for ether cannot be understood as other than an all-pervading ubiquitous substance, and this is not the property of either gases or vapours. . . . Owing to the varieties of their chemical properties, all vapours and gases should react differently on the bodies which they permeate if they were components of the ether" (*Chemical Conception of the Ether*, p. 4, 1904). MENDELEEFF'S gaseous, chemical, theory of the aether should answer JOHANNSEN'S question, "but then have the ether's molecules any smaller vibrations?" MENDELEEFF'S views are in some cases unacceptable, however, because he refused to admit the divisibility of the atom. LARMOR, in the Preface to his "*Aether and Matter*," says "Matter may be and likely is a structure in the aether, but certainly aether is not a structure made of matter. This introduction of a suprasensual medium which is not the same as matter, may of course be described as leaving reality behind us; and so in fact may every result of thought be described which is more than a record or comparison of sensations."

As to the absorption by cold hydrogen of the rays of incandescent hydrogen proving that hydrogen, and not the aether within the hydrogen being the transmitter, a grave error has here been committed because of a misunderstanding of the cause of the phenomenon; it is one of resonance, and has a complete acoustical analogy; see E. P. LEWIS, *Scientific Monthly*, August, 1918; and Prof. GUTHRIE, *Scientific Monthly*, February, 1917; or text-books of light and physics.

The present writer has not studied the question of the light of the sky, and cannot say how valuable a piece of evidence of radiation filling all space this is; but it does not seem to be necessary to postulate a finite aether in order to get this radiation; perhaps this depends upon whether or not the universe is infinite; several articles on this will be found in the volumes of the SCIENTIFIC AMERICAN SUPPLEMENT. The causes of the luminosity of the nebulæ, comets, etc., are not certainly understood; selective absorption of the radiations traversing space may play its part (FABRY, SCIENTIFIC AMERICAN SUPPLEMENT, June 8, 1918; *Astrophysical Journal*, 45: 269-277, 1917); this does not appeal to the writer as a sufficient or necessary source of the energy required to form worlds, however; this all depends upon one's personal views regarding cosmogony; the writer cannot accept SEE'S theories.

Regarding the point raised in the appended criticism to JOHANNSEN'S article: the complete explanation of the spectral differences of stars and the question of stellar evolution is not known (for a recent study, see *Astrophysical Journal*, vol. 47, No. 5), but in view of the probable course of inorganic evolution indicated by modern theories of atomic structure, it seems doubtful whether all the hydrogen and helium is disposed of by simple escape.

The question of the energy of the universe is an interesting one. The redistribution of this energy constantly tends to make the entropy of the universe a maximum; whether the time will come when all energy will be uniformly distributed, and the universe will be "dead," or whether the occasional "celestial accidents" or other causes and influences will prevent this, cannot be stated. EDGAR WOOLARD.

Boulder, Colorado.
University of Colorado.

The Ether Ball, Again

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

WHILE in my discussion of May 18th, I tried to keep as closely as possible within the limits of the subject, the foregoing criticism spreads out into many fields concerning the nature and the substance of the ether—an immense territory, which hardly should have been opened up unless, by doing so, some definite conclusion were arrived at to decide the point in question. The questionable point was, whether the ether surrounds the known universe in shape of a closed ball or lens, or whether there is no limit to its extent, i. e., whether it spreads out into infinity. The reviewer, though quoting many authorities who have studied the *nature* of the ether, states right in the beginning that the assumption of a limited ether ball is not opposed by any facts known to him. Why, then, that digression into the nature and substance of ether?

In no way can I agree with him in the concluding remark of his essay: "that it cannot be stated whether the time will come when all energy will be uniformly distributed and the universe be *dead*." If that state were *possible*, it would have materialized long ago. The continuance of stellar life proves conclusively that we are here meeting the same condition as in a nation, or in all organic realms; the now existing beings are getting old and will die off, and new ones are constantly being born and take their places. Just so with the stars. They are all dying, and the energy radiated by them is seemingly lost; but new planetary nebulæ are constantly forming, which will absorb the heat radiated by the stars, and gradually develop into stars themselves. In no other way is a restitution of energy, and a continuance of the stellar world, at all possible. The hot radiations emanating from the stars can never be returned as *hot* radiation, there being no focus where ethereal radiation, weak as it is, could converge. But they are not lost. When reflected from the limits of the ether ball they will, sooner or later, strike some nebula and be absorbed, as cold radiations; the nebula then gradually contracting, therewith getting hot, and thus changing the cold radiations, originally received, into hot radiations which it emits again when assuming stellar life.

For such kind of restitution of energy to the stellar world it seems much more probable that the radiated (and seemingly lost) energy is husbanded, and kept together within the limits of an ether sphere or lens, than that we should be dependent upon radiations from galaxies of unknown and unrevealable distances, which at best could give us only an exceedingly small share of their radiations.

N. JOHANNSEN.

Law of Densities in Gaseous Mass

APPLYING the laws of gases to the constitution of the sun, it is found that the conditions lead to the formation of an almost homogeneous nucleus, surrounded by an atmosphere where the density and pressure vary rapidly in geometrical progression. Diffusion of the vapors of the nucleus will condense in the atmosphere and form mists and clouds, the movements uncovering the nucleus in the spots.—Note in Sci. Absts. on an article by A. VERONNET in *Comptes Rendus*.

Explosive, Expansive and Perforating Bullets*

Used by the German and Austrian Armies

By Claude Pernelle

In the course of the Franco-Prussian War of 1870-1871 both the French and the Germans accused each other of making use of explosive bullets. The examination of serious wounds having an extent very disproportionate to the mass of the ordinary bullet shot by the Chassepot or the needle rifle led the belligerents to believe that balls of a special kind had been employed. In reality nothing of the kind had been done. Certainly not on the French side, at any rate, and very probably not on the German side. The effects called *explosive* are due, as we shall see, to other causes. Nevertheless, this idea was so prevalent that the powers who signed the Declaration of St. Petersberg, which in 1868 had contained a paragraph "renouncing employment, whether by their land forces or their sea forces, of any projectile weighing less than 400 grams which should be either explosive or loaded with fulminating or inflammable substances," completed this act of humanity by signing the international acts on July 29th, 1899, at the Hague. Among these was a "declaration concerning the interdiction of the employment of bullets which easily spread or flattened in the human body."

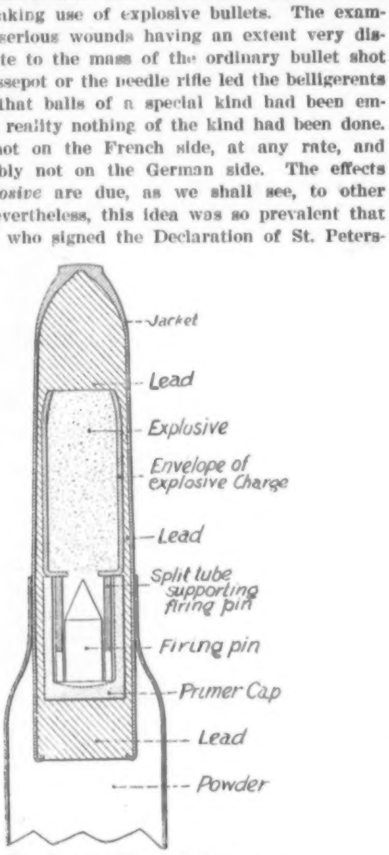


Fig. 1. Austrian explosive bullet

For Germany and Austria this declaration is merely another scrap of paper. The Germans especially have willed a war of frightfulness. More than 20 years ago Col. Koetschschau desired it ardently, and many others have thought it and said it though they may not have written it as explicitly. This is one of the principles of the great war—to terrorise by new methods as cruel as possible, and preferably unexpected, since the adversaries had been too loyal to think of making use of means opposed in a Treaty bearing their names as signatories.

Explosive Bullets.—At the very beginning of the war German and Austrian explosive bullets, prepared in times of peace, appeared in Servia. They have been so often described that it seems almost idle to reproduce them. As Fig. 1 shows the percussion is produced at the instant when the bullet encounters any obstacle, even a slight one. Their percutor, which is at the rear at the moment of discharge, is carried suddenly forward and strikes the fulminating composition at the moment when the bullet has already penetrated the body. There is no safety device to retain the percutor from being displaced in the forward direction, and returning suddenly to the rear at the moment of firing. Under such conditions displacements are produced which result in injury of the rifle.

Early in the course of the war a new explosive bullet provided with a fuse appeared (Fig. 2); this was very ingenious and could not have been brought to perfection in less than a year of effort. It was given to the German Aviators—doubtless because in the declaration of St. Petersberg only the forces by land and by sea were mentioned. By a refinement of hypocrisy these bullets were called by them tracing bullets, under the pretext that they always burst at the same distance. There is in fact only a one-time fuse, which is lighted at the moment of firing, and the bullet bursts at an average distance of 300 meters, which is the distance of combats between airplanes, with only a very slight cloud of smoke which is promptly dissipated by the wind. The explosive radius is about 100 meters, hence we see how difficult it is to accept the German pretext. It is very certain that these are fusing explosive balls of a single period of duration.

Expansive Bullets.—At the beginning the balls fired by the Gras and Lebel rifles, and afterwards by the Mauser and Mänlicher rifles, appeared to be much less dangerous than the old fashioned balls, because of their high speed and their small calibre. They were even called humanitarian bullets, as if these two words do not always conflict with each other. It was recalled that men condemned to death and shot by four or five balls did not seem to suffer—on the contrary, as we may judge by the following example: In India a native spy received at a distance of 15 paces 6 balls, 3 of which pierced his chest; he was believed to be dead and his body was untied, but scarcely was he free of the restraining bonds than the pretended dead man took to flight and could not be recaptured by the firing squad. It was necessary to send a horseman after him, and he did not catch up with him until he was 300 or 400 meters away.

It is quite certain that in many cases the new balls having an average calibre of 8 mm. and the great initial speed of 700 meters, traverse the soft parts of the body without producing extensive damage. Against such determined and resolute adversaries as our men the small calibre of the balls and their average weight of 10 gr. did not always produce a shock sufficient to break their fighting spirit. The wounded men continued to go forward instead of falling and did not retard the effort of the troops; very often the English saw fanatical dervishes reach their lines in spite of heavy firing. Hence there was some hesitation among the partisans of the reduction of calibre. They asked themselves if it would not be necessary to return to heavier balls capable of stopping the most resolute enemy by their weight and severity of shock.

To increase the calibre was a solution of the problem, however, which was undesirable from the point of view of efficiency, resulting in an arm too heavy, and too restricted a quantity of munitions. The idea then occurred to adopt bullets analogous to those used in hunting wild animals. There are various kinds of bullets of this order. Among them are the *explosive* balls, one of which is the *Pertviset* bullet, formed of two grooved pieces united by compression. The interior contains a detonating mixture of antimony, sulphide and chlorate of potash. But is should be remarked that this ball, though of terrible effect against game having hides which are not very resistant, is without effect on the great pachyderms, the elephant and the rhinoceros. As in the case of nearly all explosive balls, it is necessary to fire with a reduced charge in order to avoid explosion within the bore; hence the ball explodes as soon as it comes in contact with the hide without penetrating it.

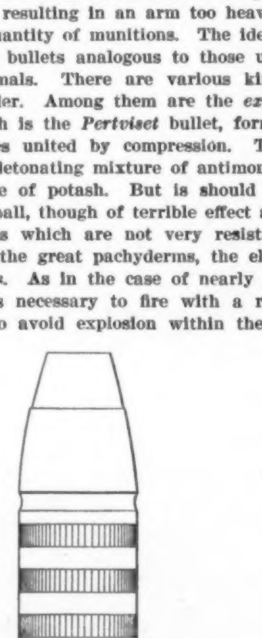


Fig. 3. Expansive bullet used by sportsmen

We recall this only because of the preceding observation which is of great interest, as will be shown later.

In reality the bullets employed are balls which are deformadable and are consequently expansive (Fig. 3). The balls fired from express rifles, for example, were all slightly hardened lead. They were pierced along their axis by a blind hole which stopped at three, four, or five millimeters from the bottom. In this hole a small brass tube was then inserted, its bottom being placed at the forward end. Such balls spread on striking because of the opening of the hole and the crowding back of the little tube; they produced enormous holes in animal flesh. They are the best of the expansive bullets, since the balls cut in sections may lose one of their segments in the bore.

It may be recalled in this connection that Commandante Journée had recommended the employment of an aluminium bullet jacketed with German silver, and formed of two parts, the forward part being of pure aluminium and the rear portion of aluminium alloyed to secure very great hardness. This idea was adopted by the Germans. Bullets whose anterior portion is not covered by the metal envelope mushroom much more easily than those which are fully jacketed. But they are capable of causing a very serious accident when fired at great speed. The non-jacketed portion may collapse, and after deformation, badly damage the arm by leading. By the time a few shots have been fired, the arm will have lost all accuracy. If the shock at firing is still more violent the ball will be broken up, and the fragments will travel at random. Damaged bullets exhibit similar inconveniences, therefore the Germans have not used them in their Mauser rifles, but they are fired from special rifles.

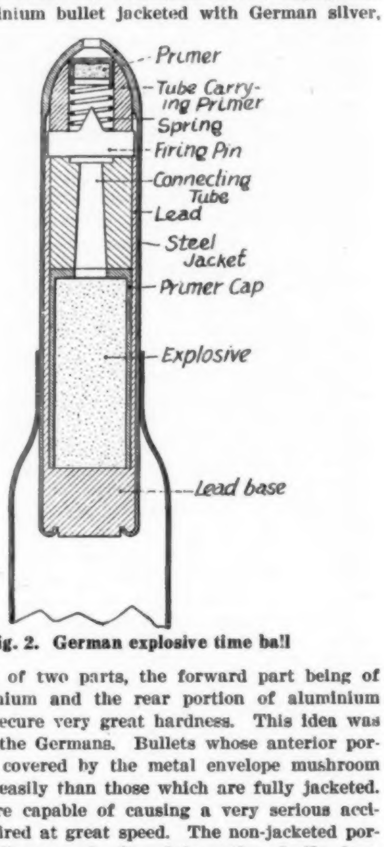


Fig. 2. German explosive time ball

Explosive Effects of Ordinary Bullets.—Moreover, it is in no way necessary to have recourse to such bullets in order to produce in a body effects quite as terrible as those due to expansive or explosive bullets. The ball fired by the old Chassepot at short distances produces quite serious wounds, and the new bullets like the S bullet were not considered to come under the head of humanitarian bullets. It must be admitted that at short distance these balls produce veritable explosive effects. With the former balls fired by Mausers the zone extended from 0 to 400 meters. With the new bullets the zone may be still further extended, even as far as 700 meters. Tests carried out in Spain show that at a short distance the effects might be disastrous. It should be noted furthermore that the stability of the new S ball, being less than of the old ball, the wounds must be expected to be more serious; the bullet in fact "tumbles" more readily and no longer traverses the body by its minimum section; its ravages are consequently greater.

Many theories have been outlined to explain the production of these serious wounds, whose aspect appears to be due to an explosion. One of the first theories was that of hydrostatic pressure, and the first person who sought to reproduce in France the explosive phenomena of the new balls seems to have been Commandante Daudeteau. He fired at receptacles full of water and attributed the bursting produced to the augmentation of the pressure. According to the Swiss

*Translated from *La Nature* (Paris) for the SCIENTIFIC AMERICAN SUPPLEMENT.

surgeon, Colonel Bercher, the bullet of the Swiss rifle produces small wounds in the heart when it is contracted, and produces an explosive effect on the contrary, when this organ is dilated. But the conclusions drawn from these tests were promptly contradicted. The view was eventually accepted that the ball projected before it, in the form of a more or less open cone, particles of debris, which acted in their turn like secondary projectiles. It must not be forgotten that the resistance of the body is very variable, that the ball does not act in the same manner upon muscles contracted and muscles relaxed, and that the portions of the body filled with liquid vary from each other greatly. Moreover, the stability of the ball plays a part in many cases.

Finally, we may here recall the remarkable observations of Melsens, who in 1882 insisted upon the air-projectile. He pointed out that the projectile exerts three different actions which succeed each other in a very short interval of time and in the following order: 1. Action due to the substance, the weight, the form, and the speed of the projectile; 2. Action due to the elasticity of the gas, whose volume suddenly increases at the moment when the bullet is stopped by a solid body; 3. Action of the solid which is deformed or broken without perceptible change of volume, and strikes solid bodies already impaired without doubt by the action of the projectile-air, the air being considered as an integral part of the projectile. Apropos of this we may note that in the beautiful Museum of War at Val de Grâce, whose installation, due to the initiative of M. Justin Godard, has been so admirably carried out by Professor Jacob, the Surgeon Inspector, there are to be found specimens of various metals at which D. balls have been fired from a distance of 10 meters. Tin and lead are metals of equal softness according to current observation, and yet the shots fired under the same conditions at plates of the same thickness proved that the tin behaves very differently from the lead. On the lead plate the exit hole is definitely greater than the entrance hole. There is no dragging, nor hydrostatic pressure, nor cone of debris, and yet there is a phenomenon of expansion, almost like that of explosion.

Perforating Balls.—The S bullet was constructed by our enemies in order to obtain penetrating effects superior to those of the old bullet. As we know, the S ball (Pointe; Spitze) is made of lead-antimony, a slight percentage of antimony being added in order to harden it, and has a jacket of cupro-nickeled steel. It penetrated dry wood of different thickness as follows:

At 100 meters, 60 centimeters.
At 400 meters, 80 centimeters.
At 800 meters, 35 centimeters.
At 1200 meters, 10 centimeters.

Sheet metal seven millimeters in thickness is entirely pierced up to 350 meters. After such a result the effort was made to obtain bullets which would be still more efficacious against the shields—of our "75 mm." guns. Shortly before the war the Germans succeeded in creating a new bullet with a very hard steel jacket containing a high percentage of carbon and a certain amount of tungsten. At the forepart of these bullets, as can be seen in Fig. 4, is a small mass of soft lead which permits the steel core to be inserted straight. Steel plates ten millimeters thick are penetrated by these at 400 meters without difficulty.

This exposition of the matter in hand, which recalls only things which are quite well known, shows how illusory is the idea of protecting the body against bullets. Moreover, the proportion of serious or fatal wounds caused by these does not reach the figure of 15%.

The proper procedure, therefore, would be the preparation as soon as possible of a light cuirass, which may be either of buffalo or other stout leather, of thin sheet steel, or even of chain mail to protect those parts of the body, subject to the most serious injury (Fig. 5).

With such a form of protection we should witness the disappearance of a great number of serious wounds produced by fragments of grenades and the shrapnel of bombs and shells just as the steel helmets have already saved many of our courageous combatants. But would such a cuirass be entirely useless as a protection against balls? Though it may be powerless in every case to offer protection against perforating balls fired from short distance, would it not diminish the extent of the zone in which explosive effects are produced by this latter, and would it remain ineffective against explosive or expansive balls? Would it not in many cases cause these to burst or to be deformed before they penetrate the body? Believing we may answer this question in the affirmative, we can but be glad to see that the Academy of Medicine is supporting with its high authority the proposition to furnish our men with a light and flexible cuirass. The idea is by no means new. Thus, we have a record of an order signed by Sully, April 12th, 1603, for the furnishing and delivery at the Arsenal of Paris of five hundred complete "Harnoys," and of one thousand "Corcelets," ordered from Philbert Godet, Bourgeois merchant of Châlons. The old French text runs as follows: "This is to witness that the said Godet has promised to the said Signeur Grand Maistre to furnish a delivery at the Arsenal of his Majesty at Paris, the quantity of five hundred complete harness, the breast plate and helmet, proof against pistol shot, and the remainder of it proof against sword strokes only."

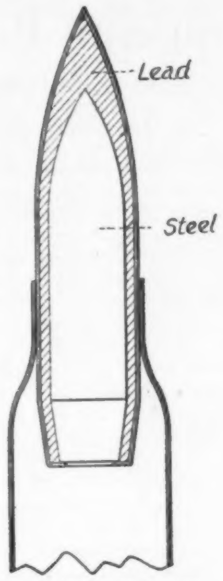


Fig. 4. Perforating bullet

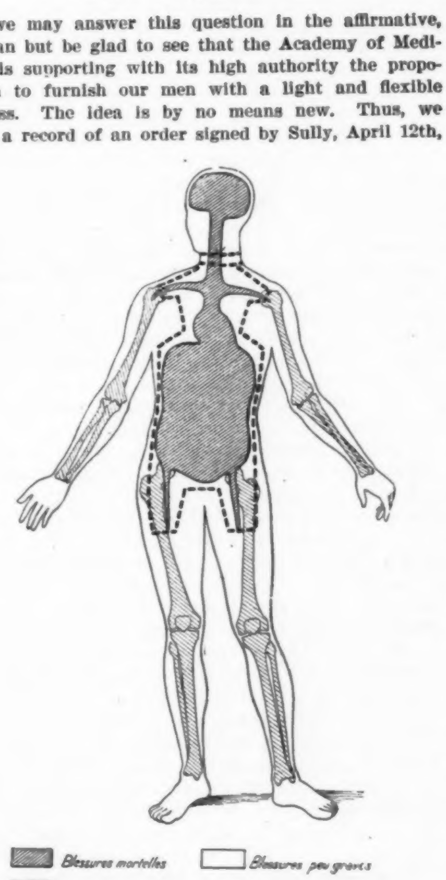


Fig. 5. Illustrating the gravity of wounds in different portions of the body

A Mississippi Barge Fleet

In the July-August Journal of the Engineers' Club of St. Louis, Baxter L. Brown, consulting engineer, gives the following details of the government's Mississippi barge fleet:

"The barges had to be so designed that they could carry economically large tonnages of low-class bulk freight like ore, coal, steel and lumber, or oil. The limiting navigable draft during the low-water season in the upper Mississippi river is 4 feet for a wide tow. The limits of length and width were imposed by bridge spans and locks. There are fourteen bridges between St. Louis and St. Paul; all but one of the bridges have clear spans of at least 150 feet, through which three 48-foot barges may be passed abreast. There are two locks, at Keokuk and at Moline, and there soon will be three, as an additional lock is being constructed on the Upper Rapids at Smith's Island, a few miles above Moline. The clear length limit at the present Moline lock is 300 feet.

"The problem, therefore, was to design craft which should handle upstream tonnage against rapid currents, and could be operated profitably on a depth of 4 feet in time of low water in a country whose rail transportation is on a lower ton-mile basis than that of any other country in the world. These barges will be 300 feet long, 48-foot beam and 10 feet deep, with 8 to 9-foot full load draft. They will be double enders, with modified spoon bows. Such a barge will carry 3,000 tons on 9-foot and 850 tons on 4-foot draft at time of low water. A tow with three such barges, which is the best approved arrangement for a river towboat, would thus carry 9,000 tons at high water and 2,500 tons at low water.

"The barges will be built with open cargo hoppers, 36 feet wide by 256 feet long and 6 feet deep, with the bottom 5 feet above the bottom of the barge. The hopper will thus leave a 6-foot deck on each side of the cargo space, which will be surrounded by a raised coaming. As the barges will be equipped with pipes and pumps they may carry oil in the double bottoms. The situation of the great oil fields of southern Illinois and Louisiana relative to the Mississippi river makes this a desirable feature.

"The fleets to be constructed under these plans will have a wider range of operating possibilities than any other river craft ever designed at home or abroad, and will operate profitably on even the minimum draft allowed. The barges will be pushed, as on the rivers of the Mississippi Valley, or may be towed tandem, as in Europe. These may be loaded with oil or with heavy bulk freights, or any other commodities that may be carried without protection from the weather.

"The upper Mississippi is a reach of river 675 miles long. The available depth of channel during the high-water months is 7 to 9 feet. The channel is relatively stable, as the river carries but little shifting sand. The stream runs through an agricultural region of great richness, but the traffic possibilities of immediate importance arise from the fact that at its upper end is a district entirely without coal, yet possessing the richest iron mines in the world, and two industrial cities having together considerably more than 500,000 inhabitants; while at its lower end is an inexhaustible field of excellent steam coal and the fourth manufacturing city in the United States."

The Food of Jelly-Fishes

Jelly-fishes are carnivorous, and live upon nothing else than their fellow-dwellers in the ocean, and these, as every one knows, they capture by means of poisoned threads shot from many armed batteries. Many feed almost entirely upon smaller jelly-fishes of other sorts, some cannibalistic forms engulf their own kind, other large species catch fishes, but most prefer the lesser organisms, especially small crustacea and fish eggs, which form a rich population in all the seas.

As this floating population is in quantity, so the jelly-fishes wax in size and strength. In our temperate seas and in the colder northern ocean minute floating life is more rich in numbers than it is in the tropic oceans; and in the cold northern oceans the largest jelly-fish are found. Recent discoveries have shown that the jelly-fish puts its surplus stores of food to good use. As it feeds it increases in size, and a great proportion of its new growth is due to the increase of the solid mass of jelly which lies between the outer surfaces of the bell or "umbrella."

To the jelly-fish this structureless mass is what its hump is to the camel—a store of food material laid up against evil days to come. When natural food runs short owing, perhaps, to the coming of colder weather, and the consequent disappearance or migration to deeper waters of the small fry of the ocean, the jelly-fish is compelled to fall back upon its own reserves of food. Its vitality is now derived in part from the absorption of its own jelly. A jelly-fish from which all food was kept continued to live for at least forty-two days, but at what cost! It gradually shrunk in size till but a ghost of its former self remained, for the jelly disappeared as energy; at the beginning of the experiment it weighed just one hundred times more than it weighed at the end.

Whether this self-sustenance is a normal phase in the yearly round of jelly-fishes, or is an exceptional response to peculiar conditions of starvation, has yet to be discovered.—*J. R., in the Scotsman.*

The Zeppelin Biplane—II*

A Description of a Monster German Bombing Machine of Recent Construction

By Jean Lagorgette

[Concluded from Scientific American Supplement No. 2237, Page 319, November 16, 1918]

THE MONSTROUS BODY.

Fuselage.—As on the smallest aeroplanes, there is a single fuselage. Its general characteristics are those of the old German fuselages built in the form of a lattice girder and not, as in the newer types, as a ply-wood monocoque as in the chaser machines, or in ply-wood with wooden frames without bracing. The length is 21.35 metres.

Longerons.—The fuselage, which is of rectangular section, has at each angle a longeron 75 mm. high and 80 mm. wide, which only decreases on nearing the tail, when it is only 47 mm. high and 75 mm. wide.

The two upper longerons are of spruce, the two lower of ash; each of the four is composed of six pieces (assembled as in section "c" in the general view of the machine), glued and wrapped with fabric. Where the struts join them they are encased in ferrules, over which the cross-bracing passes.

The two upper longerons are in a horizontal plane on a level with the axis of the air-screws for practically the whole length, and from 1.8 metres, cross measurement, they approach one another progressively in a straight line from the front of the gun-turret to the rear extremity, where the width is 1.08 metres.

The two lower longerons are horizontal from the front of the machine to the back of the gun-turret, whence they rise in a curve, so that the fuselage thins down in a horizontal line as in the Albatros and the early Fokkers. Thus, the maximum section of the fuselage, from behind the pilots to the gun-turret, is 1.8 metres wide by 1.68 metres in height, and thence it flattens out progressively.

These dimensions are concerned with the naked woodwork, but on each angle, so as to fix the fabric on the whole surface and to hold it clear of the cables, turnbuckles and ferrules, which might damage it, there has been added a wooden edging which consists of a strip of poplar, 30 by 40 mm., of the section shown in figure "c" in the general arrangement drawing. This stirp is cut away frequently to allow for the numerous and somewhat thick ferrules and it forms on each side of the fuselage, a projection of 25 mm. or about 50 mm. to be added to the total width and height of the fuselage.

At the extreme end of the fuselage each upper longeron is united to the corresponding lower longeron by a sheet steel clip, whence the extremities open out forwards. The longerons are cut diagonally, and are closed together by another ferrule which also encloses the lower elevator hinge tube.

At 3 metres from the front of the machine, above the leading under-carriage, the longerons are interrupted, and the whole of the front part can, if necessary, be removed. From this point the true upper longerons, which are of ash, 65 × 65 mm. in this vicinity, descend to the summit of two 55 mm. tubes, which come to a point at the leading extremity of the fuselage. The part above these is super-added, and is composed of wood and round light tubing, which is not part of the actual construction.

Partitions.—The upright struts are perpendicular to the upper longerons, and, therefore, for a considerable length also perpendicular to the lower longerons.

The interval between the successive partitions from the point G (general arrangement drawing) decreases towards the rear, as well as towards the front. There are two types of partitions. Behind the gun-turret, right to the tail, they are similar to the current type, each being composed of four tubes forming a frame, which, except in partition D (general arrangement drawing) are united at their angles, not directly, but by a square ferrule (sketch "d").

Ordinary cross-bracing is used. The extremity of these tubes is crossed by a piece of sheet steel, which is welded to it, and sticks outside with an eye, to which the transverse cross-bracing is fixed.

This cross-bracing is of simple 5 mm. wire in the two partitions behind the cockpit, and of 3 mm. almost everywhere else.

From the bottom of the gun-turret to the front the partitions are entirely of welded tubing, following the various forms of sections B to I, shown on the general arrangement drawing. These partitions correspond to the same letters in the plan and side elevation. All are combined in such a way as to provide a corridor or tunnel inside the whole of this particular "habitation."

The fuselage is surmounted by triangular, transverse and longitudinal girders, which serve for the suspension of tanks, and maintain the form of the back of the fuselage, which is multi-sided in this part.

Cross-Bracing.—As differentiated from the transverse cross-bracing, but in the same way as the cable bracing of the wings, the bracing of the four faces of the fuselage is composed of endless cables. These are 4 mm. cables from the tail to just behind the cockpit, and hence 5 mm. for the horizontal bracing and various dimensions for the longitudinal bracing of the sides.

INTERNAL ARRANGEMENTS.

Right in the nose of the machine, which is rounded and little raised is a place for at least one gunner-observer who is provided with a handle, probably for the bomb-dropping apparatus.

Behind him and somewhat more elevated so that there is a view behind the "habitacle" (a delightful French word for a cockpit), and protected by a transparent windscreen (partition B general arrangement) are installed the two pilots whose controls will be described later.

Behind them there seems to be a wireless operator. Then on a level with the front of the wings are two mechanics who are certainly not too many for the surveillance of the four engines with their various controls, pumps, and so forth.

From the level of the front spar to the trailing edge the multiple tanks are suspended by girths to the girder frames which have already been mentioned, and the bombs are hung under the fuselage.

Between the tanks a passage is arranged through the partitions B to I, from the front to the cabin behind the gun-turret.

Finally, in the turret there are at least two machine-gunners who can fire not only above but under the fuselage from a sort of cabin which is situated behind, and to which they have access by crawling under the partition I.

There are thus a total crew of eight or nine persons. Underneath the gun-turret is a long trap door with the hinges set longitudinally. An external ladder on the left, made of welded tubes, permits the crew to mount into the turret, and another one seems to have been fitted to the front part of the fuselage. The fuselage is covered almost entirely with fabric. The front is three-ply and sundry sheets of aluminium close the roof of the machine towards the front.

THE UNDER-CARRIAGES.

In spite of its 18 wheels, the landing system is of the most simple, but not of the most diminished. As on the Friedrichshafen and on the majority of big two-engine machines, it is composed of three parts. One is merely an accessory under the front of the fuselage.

The Front Under-carriage is composed of two widely opened V's, each practically in a longitudinal plane.

Between the elbows of the two V's for a space of about .35 ms. are welded 30 mm. tubes, to which are fixed the rubber shock-absorbers. The two wheels which are .9 ms. apart, have rims of .48 m. diameter by .11 m. wide.

The Main Under-carriage.—This is situated at the level of the motors, under the wings, which particularly, for this reason, have neither a V nor an arrow.

Being subjected always to considerable strains, it is possible that the original under-carriage was miscalculated, which seems to be indicated by the inscription "Verstarkt" ("re-inforced") on each, from which one judges that several modifications have been made in the original arrangements.

The axle, enormous, and fatter than those of railway waggons, is of 110 by 120 mm. tube, and carries at each end two pairs of twin wheels. That is to say, eight wheels for each under-carriage.

The rims are 700 mm. diameter by 120 mm. wide. The tyres appear to be about 1,000 mm. (1 metre) in diameter. Each of the cables of the tyres consists of a bundle of about 20 steel wires.

Almost all the pieces of the under-carriage are autogenously welded. The whole thing appears to be strong, but the wheels alone form a cylindrical surface, of which the section is about 2.8 sq. ms., and this must offer considerable resistance to progress.

The Tail Skid.—This is single and of the usual type, pivoted under the middle to a lower fuselage cross-strut. This cross-strut is united to the cross-strut behind it by two tubes in a V and to the cross-strut above it by three tubes forming an A, upside down. The points of the V and of the A meet at the pivot. The sandows are fixed to the bar of the A which is itself braced to the upper cross-strut of the partition behind it.

This tail skid is a single piece of ash, 1.2 ms. long, 70 mm. diameter at its upper part, 110 mm. diameter at the pivot and then square with a side of 110 mm. enlarged at the lower end by a steel sole.

CONTROLS.

For transverse and longitudinal control there are two vertical levers of aluminium tubing, plugged with wood at the base only, permanently mounted on a single transverse axle and each furnished with a wheel.

The levers operate in the ordinary manner for longitudinal control. That is to say, they rock backwards and forwards, but they are fixed transversely and the operation of the ailerons is obtained, as in all the old German biplanes, by the wheels which operate cables through pulleys. These aileron cables of 5 mm. pass into the lower wings along the rear spar and thence by pulleys to the ailerons and their two levers.

Each elevator has only two levers.

The three rudders are controlled by means of two horizontal rudder-bars, and sectors and pulleys guiding the cables along the side of the fuselage as on old L.V.Gs and almost all German aeroplanes.

After passing over a horizontal pulley on a level with the fifth partition from the end of the fuselage, the cables divide out horizontally and very obliquely, traverse the outer fixed fins by an opening in their base and thus to the rudder lever.

ARMAMENT.

The armament consists of at least four machine-guns, and possibly six. One at least is placed in front of everything.

A huge gun-turret of 1.4 m. internal diameter is situated behind the wings. It is composed of two tubes of 28 mm., each forming two circles one on top of the other, 30 mm. apart, connected together and fixed to the fuselage.

On each side, a little behind the middle, a gun-mounting is permanently fixed between the turret and the longeron, to which it is clipped by a collar. The gun-mounting is in the form of a "Z," which can turn on itself, and allows the gun to point downwards outside the fuselage without circulating round the turret. These two mountings make it possible to fire over the sides and upwards, as well as towards the rear.

It is possible that other machine-guns have been installed at the back of the turret to fire backwards and upwards; also the compartment behind the turret makes it possible to fire below the fuselage.

There exist, it seems, only two bomb-carriers, but each is for a bomb of 1,000 kilos. (about 1 ton). They are suspended longitudinally under the fuselage between the wing-spars, to which they are fixed by two collars at each end.

It goes without saying that such bombs are not suitable for all sorts of objectives, even if their ratio of action compensates for their small number.

ENGINES.

The four independent engines are placed on the same level, two by two in opposite directions, one being a prolongation of the other with an interval between. Being of the same model they thus turn in opposite directions. The same disposition of engines was tried in France in 1916.

Each of them is held in a rocker between the two legs of a cabane front and rear, half of their length being in front and half behind. Each of their bearers, to which they are bolted direct, is a girder composed of two pieces of ash with a layer of ply-wood vertically between them.

The whole is held up by a complex wooden frame—uprights of wood and sheet steel 50 mm. wide by 300 mm. high and 450 mm. apart—which on one part butt up against the cabane and on the other part hold up by the intermediary of a cross-strut, the gearbox and the airscrews.

Each cross-strut rests on two tubular sockets of 55

*An abstract of a paper published in *The Aeroplane*, London.

mm., which are adjustable at the base, and rest against the base of the cabane on the wing spar. Cable cross-bracing of a complex nature completes the edifice.

These cabanes are built of two tubular "A's," 55 × 60 mm. in the front, and 60 × 65 mm. on the rear, and not of two "V's," as on the Friedrichshafen. This composition seems quite favorable against smashing, and gives four points of union at the summits of the undercarriage.

Each base and summit of the cabane is united to the corresponding wing-spar by a clip of 3 mm. sheet steel, 230 mm. wide.

A bonnet of aluminium, at any rate in front, encloses the engines.

These motors are 6-cylinder vertical Maybachs, but their power, which is ordinarily about 250 h.p. in this type, seems to have been forced up to 300 h.p., or 1,200 h.p. in all.

The height of the engine is .85 m. and the length 1.75 m., of which 1.12 is taken up by the 6 cylinders.

It is worthy of note that the German authorities impose on the engine constructors limited dimensions, lengths of base and other characteristics, which permit the interchangeability of different makes of engines.

On the Zeppelin airships of the L.30 series, each of the Maybach motors, of 150 mm. bore and 199 mm. stroke, developed a power of 240 h.p. at 1400 r.p.m.

Two of the motors are provided with a species of gear, almost destroyed, probably a starting-gear.

Airscrew Gearing.—Instead of the airscrew being mounted directly on the shaft, the following arrangement is interposed:

1. A fly-wheel of cast iron of .4 metres diameter, unlike anything which exists in any other German aeroplane.

2. A connection in aluminium with plates of leather in notches, .36 metres diameter, of which the female part is half engaged in the fly-wheel.

3. A transmission tube, very short indeed for the front engines but .75 metres long in the rear engines.

4. A gear-box containing two toothed pinions in an aluminium case, made in two parts and bolted together horizontally.

By this gearing the axis of the air screw is placed 170 mm. above the axis of the motors, and its level corresponds thus with the upper longeron of the fuselage.

Under this one finds an oil reservoir-radiator, semi-cylindrical in shape, .35 by .1 m. thick, with 20 mm. tubes running through it. This has a pump at the base and two electric thermometers.

AIRSCREWS.

The axes of the airscrews are 6.8 metres apart, laterally, and the bosses of the screws are 5.8 m. apart fore and aft. The screws are two-bladed, of 4.3 metres diameter, as against 5.4 ms. in those of similar types in the Zeppelins of the L.30 series.

From .185 m. towards the boss the thickness changes quickly to .3 m. The maximum width of the blade is .4 m. There are about a dozen laminations, mostly in badly chosen spruce with knots in it, except one which is in mahogany, and the whole length is covered by a thin layer of ply-wood.

ACCESSORIES.

As we have seen, the tanks are suspended to the upper part of the fuselage level with the wings. By each motor there is a gravity tank suspended by two little tubes to the inside leg at the bottom of the cabane at a level with the cylinders. A pump is placed in the fuselage on a level with the front wing spar.

The radiators, of N.I.G. type, and .2 m. thick, .4 m. high and .85 m. wide. Of this width .23 m. consists of a supplementary section, which can be added or taken away as required. The radiators are placed in front and at the top of each "A" of the cabane. They are suspended by two vertical cables.

Electric lighting is installed. Six fire extinguishers were found among the wreckage.

All the fabric is of poor quality, and is camouflaged with dark colored hexagons, dark blue or violet, on which the black cross does not stand out. The paint used offers little resistance to oil and petrol.

If one reckons on a total weight of 12,600 kilograms, the upper spars of ash must work at a pretty high stress. The most fatigued part, situated immediately outside the engine cabanes, works at 1.7 kilograms per sq. mm. On the same reckoning the spars on the lower plane work at 1.3 kilograms per sq. mm.

The figures for the work of the interplane struts of steel tubes vary from 1.1 kilos to 3.8 kilos per square mm.

Some of the cables vary from 10 kilos. to 25 kilos. per square mm. The cables are flexible and of quite good quality.

If the weight is 12,600 kilograms, the surface 314 square metres and the horse power 1,200 the load would be 40 kilograms per square metre—which is not enormous—and 10.5 kilos. per horse power.

It seems unlikely that the speed of this machine is more than 120-125 kilometres per hour.

As to the general appreciation of the Zeppelin. It is permissible for anybody who sees it to formulate their appreciation according to their fancy or their humour, but anyone who tries to present a study of the machine without prejudice owes it to his reader to suspend, as to its flying qualities, any judgment which does not draw its elements from presonal observation, or from that of competent and conscientious persons.

The Eulachon—A Delicious Food Fish*

The finest food fish in the world, tender, fragrant, digestible, is the eulachon (*Thaleichthys pacificus*), known to the trade as the "Columbia River smelt." It belongs to the smelt family (Argentinidæ), but it differs widely in habit and substance from the two species of smelt found on the two shores of the North Atlantic, and its nearest relative is the capelin of arctic and subarctic waters.

The eulachon has much smaller scales than the true smelt. Its flesh is more tender, more substantial, and at its best extremely full of oil, but this oil, unlike that of the mackerel and the salmon, is very delicate, and very easy of digestion.

The eulachon is a slender fish, dusky olive in color, about eight inches in length. It is found on entering the mouths of the rivers to spawn in midwinter, and not going far out to sea at any time. The spawning males have little warty edgings on the scales, making them velvety to the touch. The eggs are very small and white, deposited by the thousand between tide marks on the sand of the river mouths. Just now, February, 1917, the beaches at the mouth of the Columbia are lined with these fishes. They can be shoveled up and shipped in boxes; they sell at three to five cents a pound in Portland. These are spent fish. Probably they would die, even if put back into the sea. Whether any survive the spawning act is uncertain. To die after spawning, the protoplasm in the cells being exhausted as in a dead cornstalk, is a common attribute of many fishes in the Pacific. The six pieces of salmon, the Japanese icefish (*Salangichthys*), and the capelin (*Mallotus*), all perish after the first sex impulse. For this reason, the eulachon is at its worst when it comes into the market, soft, mealy, and with scanty oil. Even then, no fish is better, and at the ruling prices it makes a nick in the high cost of living in the Northwest.

It is said that when a eulachon is at its fattest, in the fall, a wick can be drawn through the body and it will burn like a candle. Hence it has been called in books (nowhere else) "candlefish." The Indians of southern Alaska carve vats in the rocks, fill them with eulachon, and with hot stones try out the oil, which they greatly appreciate. But the oil extracted from rotting fish has an odor of its own which it takes a hardened Indian to appreciate.

The Indian name of the fish, as I have heard it among the Chinooks, I should spell "oulchn." But one of the early explorers wrote this same word "eulachon," which is quite pronounceable and has a Greek look, and this name should be kept, not lost in the expressionless "Columbia River smelt." The species was first named by Sir John Richardson in the *Fauna Boreali-Americana*, in 1836. But in the notebook of William Clark of the Lewis-Clark Expedition about 1805, we find this memorandum, accompanied by a fair pen sketch of the fish:

"I think them superior to any fish I ever tasted, even more delicate and luscious than the white fish of the Lakes which have heretofore formed my standard of excellence among the fishes. I have heard the fresh anchovy much extolled but I hope I shall be pardoned for believing this quite as good. The bones are so soft and fine that they form no obstruction in eating this fish."

The capelin (*Mallotus villosus*) is very much like the eulachon, a little larger in size, and in the males some of the scales in rows, are produced, making the whole surface of the fish wooly to the touch. This is a northern fish, native to Greenland, Siberia, and Alaska; and to the Indians and the Eskimos, both in Greenland and Alaska, it is of the greatest food value. It spawns in the surf, and the falling tide leaves it by the million on the islands of southern Alaska. It lines the beaches in summer as the eulachon farther south does in the winter. But the eulachon chooses the river mouths while the capelin is satisfied with any sandy beach.

The little icefish or whitebait (*Salangichthys*) of the rivers of Japan runs in the summer time in the streams. It is a small, tender, translucent creature not three inches long, but it has the salmon habits, and the delicate flavor of the smelt. We suppose this to be its life history, although the details are not proved. It runs in the summer and casts its spawn in the brooks. The young fish slip down to the sea in the fall, tail-foremost, "in the old salmon fashion," and, as we believe, they return the next summer to spawn and die. If this be true, it is an annual fish, each generation renewed each year from the eggs of the one before.

Another little transparent "smeltling" is the New Zealand whitebait (*Retropinna*). This is now largely canned as a food product, the flavor of the preserved flesh being excellent.

Of the true smelt (*Osmerus*), with large loose scales and sharp teeth, Europe has one species (*Osmerus eperlanus*), and eastern America another (*Osmerus mordax*). The North Pacific is better supplied. One species (*Osmerus thaleichthys*) is common in California. A larger and finer one, the surf smelt (*Hypomesus pretiosus*), spawns in the surf northward, and the pond smelt of Alaska (*Hypomesus inghaghitsch*) spawns in brackish ponds northward. The rainbow smelt (*Osmerus dentex*) is common in the North, and a species large and rare (*Osmerus albatrossis*) lives near the surface in the open sea. Another, with feebler teeth (*Spirinchus verecundus*), clings to the streams of Korea.

None of these is so remarkable as the fur seal smelt (*Therobromus callorhini*), in the open sea about the Aleutian Islands. Of this dainty little fish no naturalist has ever seen a perfect specimen, but the tender bones have been taken by the thousand from the stomachs of fur seals feeding out in the sea. Dr. Frederic A. Lucas has made a restoration of this animal as if it were a fossil.

Other fish of the smelt kind, *Microstoma* and *Nansenia*, are found in the deep seas of the Arctic, and still others, called *Argentina*, in deep waters farther south. The whole group seems to be an offshoot of the trout and salmon race, carrying the adipose fin, the badge of all that race, as well as of the wholly unrelated race of the catfishes. This fin is probably a remnant of a once continuous fin-fold which existed before it was stiffened up with fin-rays.

*David Starr Jordan in *The American Museum Journal*.

The Choice of a Lens

(*Continued from page 330*)

The beginner is well advised to get a complete outfit, and to take the lens which the makers think to be most suitable in focus. The beginner also is more likely to wish to photograph subjects irrespective of whether he can get far enough from them to get a good perspective rendering; and, therefore, he will regard a lens of comparatively long focus as imposing needless limitations on him. The more advanced worker, who has learned to attach more importance to the rendering of his subject, and who has ceased to be keen upon merely recording things, will find that the longer focus lens more often gives him what he wants; and will not be particularly sorry to have the temptation to do wide angle work removed.

In no class of photography is focal length more essential than in portraiture. It is much more important to have a lens of long focus of any kind than it is to have a regular "portrait lens" of short focus. Here again is a fine field for instruments of the Telecentric kind: since they give the long focus required, and at the same time are rapid, and do not entail any great camera extension.

The modern anastigmat, in certain patterns, has another advantage for all-round work which to some extent is shared by the rectilinear. One of its combinations can be used by itself when we require a lens of longer focus. Such a single lens should always be used for portrait work, in preference to the complete lens, if the focus of the complete lens is not fairly long. It is true that the exposures with the single lens are necessarily much longer, as the f/ number of the stops is increased in the same proportion as the focus is lengthened; but unless the lighting or the sitter absolutely precludes the longer exposure, the improvement in perspective rendering is well worth the price paid for it in rapidity.

An alternative, of course, is to use the whole lens, and so get the advantage of its rapidity, but to use only half the plate or even less, being satisfied with the smaller image. Where enlarging is done this is preferable. We not only get the rapidity, but we save in plates, since each plate can be used for two pictures instead of one.

Extraction of Potash from Kelp*

By C. A. Higgins

THE recovery of potash from kelp, and the utilization of kelp ashes, principally as a fertilizer, is an art that has long been practiced. Many centuries before the German Syndicate began to market potash salts from their Stassfurt mines, the crofters around the rocky shores of Scotland and the Northern Coast of France had burned the drift kelp as a fuel and scattered the ashes over their land as a fertilizer. The great success which resulted from the use of this kelp ash on the land caused a rapid expansion in the business of kelp harvesting, until about the beginning of the 19th century, quite a flourishing industry had already sprung up.

The opening of the German potash mines, however, about the middle of the nineteenth century, began to flood the market with potash at a price far below that at which the old kelp burners could produce it, and although the kelp-potash industry still struggled along in isolated parts of the coast among the Scottish crofters, and to some extent in Japan, it may be said that the German production killed the kelp industry, which had up to that time attained fairly considerable proportions.

The outbreak of the present war, however, drove potash users to look for new sources of supply, and naturally one of the first to come to their attention was kelp. Previous to the outbreak of the war many writers had drawn attention to the huge perennial beds of kelp which grow practically uninterrupted all along our coastal waters on the Pacific side, from the Mexican line to Alaska, and around the scattered groups of islands which lie close to the California shore. These vast fields of kelp seemed to offer inexhaustible supplies of potash, which, according to the preliminary survey made by the Government, bade fair to supply far more than the normal requirements of our country for the indispensable muriate of potash. All that remained was to devise economical means for harvesting these vast beds, and drying and reducing the kelp to a suitable condition for transportation and use as a fertilizer. Within a few months, therefore, of the cutting off of the German muriate, various large companies were prospecting the Pacific coast for suitable sites on which to erect plants for the harvesting and extracting of potash from the Pacific kelp.

A few figures will show the status of the kelp-ash industry in this regard. Using the modern harvesting methods, experience shows that it costs around $1.10 to harvest and bring a ton of kelp leaves ashore. Analyses show that the average potash content of the raw kelp as harvested in California coastal waters is about 1.3 per cent K_2O, which means that it costs about $85 to bring in the green kelp equivalent of 2,000 lb. of 100 per cent K_2O. On top of this, of course, has to be added the costs of drying these kelp leaves, which contain about 90 per cent of moisture, and by reason of their gelatinous and cellular structure, present quite a problem in desiccation All indications seem to point very clearly to the fact, therefore, that any industry which looks to the production of potash from kelp on a permanent peace-time basis, must reduce its cost very considerably, or produce valuable by-products in the same process which in turn will effect a reduction in the cost of the potash.

Along these lines certain investigators have suggested as far back as a century ago that the peculiar algin bodies present in kelp might be profitably recovered and used in certain directions in place of gelatin, for the sizing of paper and textiles, the proofing of cloth, and in the production of rubber substitutes and admixtures. Another interesting suggestion is that of Prof. T. C. Frye, who made a conserve by first leaching out the potash and soluble salts and afterwards soaking the kelp in cane sugar solution flavored with lemon. In Japan a kind of sour pickle with vinegar is made from the fleshy parts of the kelp. The kelp fibre when compressed and dried also forms a hard substance resembling ebonite or vulcanized fibre, and at least one concern is working along these lines at the present time. The production of by-product iodine from kelp, however, has long been a practical proposition, although hampered somewhat by the competition of by-product iodine from the Chilean nitrate fields.

The biggest practical advance in the economical production of potash from kelp was marked in the year 1915, when the Hercules Powder Company started the construction of large gasoline-propelled marine kelp harvesters and a factory located near San Diego, California.[1] This equipment was designed primarily for the production of acetone, potash and iodine from kelp. Kelp as a source of acetone was something entirely new to chemical industry, and chemists all over the world have watched the growth and development of the undertaking with great interest. The plant since its inception has rapidly increased the number and range of its products, and placed upon the market some new materials which are full of industrial promise.

Reduced to its simplest terms, the basic principle of this process of kelp reduction lies in the destruction of the cellular tissue of the kelp leaf by fermentation, bringing the potash into solution, and producing acetic acid as the product of the fermentation of the kelp leaf. The acetic acid is neutralized with limestone, giving calcium acetate, potash, and iodides in the solution.

The kelp is harvested and brought to the plant, pumped from the tank barges into the fermentation vats where it is allowed to ferment until the kelp leaf goes in to solution and a liquor is obtained which on evaporation and concentration yields, at various stages, three intermediate salts.

The first intermediate salt, consisting of a mixture of acetate of lime and muriate of potash, is heated in regular acetone retorts, which produce acetone from the acetate, leaving as residue muriate of potash and calcium carbonate, from which the high-grade muriate is separated by leaching and subsequent crystallization. The fractionation of the crude acetone yields a certain amount of light and heavy acetone oils, in addition to the C. P. acetone.

Intermediate salt No. 2, consisting of the calcium salts of the higher fatty acids, is mixed with alcohol and sulphuric acid and the corresponding ethyl esters produced by well-known methods. These esters are easily separated by fractionation. Ethyl acetate, ethyl propionate and ethyl butyrate in commercial quantities are now on the market from this source and are finding very extensive application as solvents in the soluble-cotton industry, in the manufacture of artificial leather etc.

Intermediate salt No. 3, consisting principally of potassium iodide, is treated with chlorine and the precipitated iodine dried and resublimed.

The last of the final products is algin. This substance is at the present time being produced from the residual unfermented leaves which are screened from the liquor coming from the fermentation vats. These leaves are treated with sodium carbonate which extracts the algin in the form of a soluble sodium salt which is afterwards precipitated and purified. So far, but little progress has been made in the commercial development of the use of this algin as an article of commerce. The perfection of extraction manufacturing methods however, and the increasing cost of gelatin and vegetable gums, leads to the conclusion that this material may find a very extensive use in the future.

In addition to the foregoing valuable products, promising experiments are now in hand whereby ammonia, valeric, and caproic acids are being recovered as by-products in the fermentation of kelp. Nitrogen combined as ammonia exists to the extent of about 0.2 per cent in kelp, and is left in the liquor after fermentation of the leaf. Valeric acid as the isoform is much needed at the present time in the treatment of nervous disorders, the supply of the valerian root from which the medicinal valerates were formerly made having been almost entirely cut off.

It may be a little early yet to speak definitely of the future of the kelp industry and its future bearing on potash. Certain it is that with kelp-production factories extending all along the Pacific Coast, our domestic demands for potash cannot be met thereby. Certain it is, too, that kelp solely as a source of potash will never compete with unrestricted supplies from Europe or even with that recovered in modern cement or blast-furnace practice. The utilisation of kelp in such a way, however, as to realize on all its other possible values, some of which have been touched upon, may help to render the users of high-grade potash for chemical purposes outside of the fertilizer trade, independent of foreign supplies.

*An illustrated address at the Fourth National Exposition of Chemical Industries at New York, from a report in *Chemical and Metallurgical Engineering.*

[1] Illustrated article in *Chemical and Metallurgical Engineering*, June 1, 1918.

Acetylene Silver

CONTRADICTORY statements have been made about the explosion of the acetylene compound of silver, the decomposition being sometimes merely rapid and not accompanied by any report. Examining the compound, Dr. John Eggert, who presented a paper on the subject to the April meeting of the Bunsen Gesellschaft, found that when there is a report, there is also considerable evolution of gas, while in the absence of a report there is hardly any gas evolution, and that the mode of preparation of the compound is important. The acetylene silver is precipitated when a current of acetylene is passed through a solution of silver, either acid silver nitrate, or ammoniacal silver nitrate; there are other methods. In the former case (acid solution), the compound may give off 17 cub. cm. of gas per 100 milligrams of compound; in the latter case there is generally only one-tenth of that volume of gas, and to obtain a pure compound, the ammoniacal solution should be diluted. When the explosion takes place in a small glass vessel, the walls become coated with soot and silver; these solid particles do not travel far from the flame, however, as Eggert showed by experimenting in glass tubes, up to 1.5 m. in length.—*Engineering.*

SCIENTIFIC AMERICAN SUPPLEMENT

Founded 1876

NEW YORK, SATURDAY, NOVEMBER 23, 1918

Published weekly by Munn & Company, Incorporated
Charles Allen Munn, President; Orson D. Munn, Treasurer
Allan C. Hoffman, Secretary, all at 233 Broadway

The Scientific American Publications

Scientific American Supplement (established 1876) per year $5.00
Scientific American (established 1845) 4.00
The combined subscription rates and rates to foreign countries including Canada, will be furnished upon application.
Remit by postal or express money order, bank draft or check

Munn & Co., Inc., 233 Broadway, New York

The purpose of the Supplement is to publish the more important announcements of distinguished technologists, to digest significant articles that appear in European publications, and altogether to reflect the most advanced thought in science and industry throughout the world.

Back Numbers of the Scientific American Supplement

SUPPLEMENTS bearing a date earlier than January 1st, 1918, can be supplied by the H. W. Wilson Company, 958-964 University Ave., Bronx, New York, N. Y. Please order such back numbers form the Wilson Company. Supplements for January 1st, 1918, and subsequent issues can be supplied at 10 cents each by Munn & Co., Inc., 233 Broadway, New York.

Table of Contents

, 1918

repara-
silver
passed
ate, or
ls. In
ay give
und; in
of that
d, the
n the
e walls
articles
Eggert
1.5 m.

AN

1918
ed
reasurer

ar $5.00
. 4.00
ountries
n.
check
York

publish
distin-
t arti-
s, and
thought
d.

can

January
n Com-
c, N. Y.
n Com-
l subse-
y Munn

are in a
branch
mposed
s, thor-
tent ap-
of the
chnical,

ld, who
ark ap-
United

.,
tors,
dway,
k, N. Y